NATURE

No. 4211 SATURDAY, JULY 15, 1950 Vol. 166

CONTENTS

	Page
International Scientific Liaison	81
The New Cosmology. By Prof. Herbert Dingle	82
Grassland Farming in Great Britain	83
A South American Anthropological Symposium. By Dr. G. H. S. Bushnell	83
Studies in Greek Archæology. By R. M. Cook	84
Sugar Throughout the Ages	84
A Survey of Dermatology	85
United States Science Offices Abroad. By Dr. C. E. Sunderlin	87
Physical Chemistry of Drug Action. By Prof. Adrien Albert	88
Operational Analysis and the Nature of some Physical Concepts. By Dr. G. J. Whitrow	91
Antibiotics in the Soil. By Dr. A. C. Thaysen	93
News and Views	94
Effects of Radio Gyrointeraction and their Interpretation. By Mario Cutolo	98
A Microscopic Electrophoresis Cell. By Prof. A. J. Rutgers, L. Facq and Dr. J. L. van der Minne	100
Quantitative Inheritance	102
Scientific Development and Industry	103
Letters to the Editors:	
Nomenclature of the Steroidal Sapogenins.—Dr. G. Rosenkranz and Dr. Carl Djerassi	104
Mechanism of the Rearrangement of Quinamine to *Iso*Quinamine.—C. C. J. Culvenor, L. J. Goldsworthy, W. S. Kirby and Sir Robert Robinson, O.M., F.R.S.	105
Synthesis of Ergothioneine.—H. Heath, A Lawson and Prof. C. Rimington	106
Stereochemical Course of Reactions at Steroid C_{17}.—Prof. C. W. Shoppee	107
Structure of *Trans*-Potassium Dioxalato-Diaquo-Chromiate.—Dr. J. N. van Niekerk and F. R. L. Schoening	108
Reactions of 9-Anthraldehyde in Sunlight.—Ahmed Mustafa	108
Thermal Decomposition of Potassium Perchlorate.—Dr. A. Glasner and L. Weidenfeld	109
Are Tyrosinase and Thiol Groups Present in Skin Epithelium?—Prof. H. Burton and Dr. J. M. Williams	110
Low-Cost Air Transport of Radioactive Substances to South Africa.—E. C. Halliday and Tikvah Alper	110
Ultra-violet Radiation in the Sea.—N. G. Jerlov	111
Isotopic Composition of the Oxygen in Silicate Rocks.—Peter Baertschi	112
Applications of Polarimetry to Infra-Red and Micro-Wave Spectroscopy.—Prof. A. Kastler	113
Ultrasonic Absorption in some Mixtures of an Unassociated and an Associated Liquid.—Dr. D. Sette	114
Anharmonicity of the Lattice Oscillations in the Alkali Halide Crystals.—Sir Kariamanikkam Krishnan, F.R.S.	114
Modification of a Fingerprint by a Skin Graft.—Prof. Cyril John Polson	115
'Weber's Glands' and Respiration in Woodlice.—Dr. H. Gorvett	115
Identity of a Muscle-inhibiting Flavone in Lucerne.—W. S. Ferguson, de B. Ashworth and R. A. Terry	116
Statistical Planning in Experiments on the Isolated Rat Uterus.—J. G. Fletcher	117
The Soil-Plate Method for Isolation of Fungi from Soil.—Dr. J. H. Warcup	117
A Percolating Respirometer.—Dr. Howard Lees	118

Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831
Telegrams: Phusis Lesquare London

Advertisements only should be addressed to:
T. G. Scott & Son, Ltd., Talbot House, 9 Arundel Street, London, W.C.2
Telephone Number: Temple Bar 1942
The annual subscription rate is £4 10 0, payable in advance, inland or Abroad

All rights reserved.

Registered as a Newspaper at the General Post Office

INTERNATIONAL SCIENTIFIC LIAISON

THE report "Science and Foreign Relations", issued by the United States Department of State*, which is summarized in an article on p. 87 of this issue, is to be warmly welcomed. In essence, the recommendations made by the U.S. Department of State International Science Steering Committee under the chairmanship of Dr. L. V. Berkner, and unanimously approved by the Advisory Committee of the U.S. National Academy of Sciences under the chairmanship of Prof. Roger Adams, strongly endorse a policy which *Nature* has been urging for some years past; though the present recommendations go much further in their practical suggestions for putting such a policy into effect.

There are to-day many basic and profound problems in international relations which have been raised by the very fast-moving developments in science and technology. Moreover, in spite of the efforts of most countries to keep certain scientific discoveries and developments secret (efforts inspired mainly by the present-day grave international political situation), there is still much room for further international collaboration and liaison in things scientific.

In order to stimulate this collaboration and to avoid duplication of effort and to render aid to the less-advanced countries, *Nature* has for several years advocated the policy of appointing scientific attachés to the various embassies and legations of the world. One of the first of such men to be appointed was Prof. Eric Ashby, who represented Australia as Counsellor in the Australian Legation in Moscow during 1942-43. Scientific liaison between Great Britain and the United States has for some time been put into effect, up to a point, through the British Embassy in Washington and the American Embassy in London. To what extent similar liaison has developed further between these two countries and to what extent it exists at all between others is difficult to say; but that such developments in international scientific relations are now essential cannot be denied.

The Berkner Report goes a long way towards implementing our conceptions of international scientific collaboration within the framework of a policy of democracy. It goes fairly fully into the problems concerning: (1) collection and dissemination of scientific information outside the country concerned; (2) support of international scientific organisations and conferences; (3) scientific information and educational exchange programmes; (4) technical assistance; (5) controls over the international flow of scientific information, personnel and material; (6) the role of science in the formulation of foreign policy; (7) Department of State organisation for science; (8) inter-agency relationships; (9) overseas science staffs.

It is good to note that the Report recognizes the emphasis that should be placed on the non-political

* United States Department of State. Publication 3860: Science and Foreign Relations (General Foreign Policy Series, 30). Pp. viii + 170. (Washington, D.C.: Division of Publications, Office of Public Affairs, 1950.)

aspect of science, especially in recommending that private institutions should be utilized in conjunction with government agencies. It must be noted, however, that such is the conflicting state of the world's different political ideologies to-day that the American committees recognize that "in present dealing with Iron Curtain countries certain positive actions and even control may be required".

This Report and its eminently sound suggestions for carrying out its recommendations and advice are very encouraging, and it is to be hoped that British (and indeed other) authorities will not be long in digesting it entirely with the view of contemplating action along similar lines. If, and when, the time comes for putting into effect this very desirable, even essential, international scientific liaison programme, it is to be hoped that those responsible will fully appreciate the need for appointing men of exceptional calibre and breadth of vision—a fundamental need not always recognized in the past where other fields of international scientific collaboration have been concerned. The first-class research worker is not always the best man for such a job. The man must have a very broad outlook, be quick to note immediate values and long-view potentialities and, above all, must himself be free from any suspicion of intense party-political bias or political ideology.

We hope Dr. Sunderlin's succinct account of the Berkner Report will inspire all men of science, politicians and diplomats to read the full Report and to take appropriate action.

THE NEW COSMOLOGY

The Nature of the Universe

A Series of Broadcast Lectures. By Fred Hoyle. Pp. v+121+6 plates. (Oxford: Basil Blackwell, 1950.) 5*s*. net.

THIS book contains the recent broadcast lectures through which Mr. Fred Hoyle succeeded so conspicuously in stirring public interest in problems of astronomy and cosmology. The original scripts seem to have been printed without modification, so that, for example, even references to "last week" have not been redirected to "the last chapter". This is unfortunate, but perhaps time was held to be of paramount importance.

The lectures deal mainly with the origin and development of the solar system, the stars, the galaxy and the universe; questions of structure receive comparatively slight attention. The title is well chosen, for the word 'nature', in its literal sense of birth, can rarely have been more aptly applied. The general scheme of things that is presented forms a connected whole, not, of course, without loose ends, but free from fundamental divisions. It is essentially Mr. Hoyle's own view. Whereas many successful expositors of the past—for example, Sir Robert Ball—brought to the general reader the common view of the astronomical world, Mr. Hoyle describes the cosmical process as he himself sees it. This is quite legitimate; but some indication of what is generally accepted and what is peculiar, or almost so, to the author might have been expected.

Mr. Hoyle has two outstanding qualifications for this work. In the first place, he has imagination—not only the power to conceive new ideas, but also the ability to work out their consequences and visualize their implications. He can look out on the universe with vision unperverted by conventional expectations and can bring fresh ideas to bear on old problems. For the task of popular exposition, this quality is unfortunately insufficiently offset by critical discrimination; but in the prosecution of astronomical research it is of the greatest value. In that field, Mr. Hoyle may be given full scope to advance new hypotheses, and others may be trusted to separate the sheep from the goats. It is reasonable to expect that he will play a leading part in the development of theoretical astronomy in the coming years.

His other quality is the ability to hold the reader's attention and carry him forward with understanding to the conclusion of the whole matter. He can speak of "various varieties" and write sentences (not to choose the worst) like "A long list of this sort of statement could be compiled", and still leave the reader unwilling to exchange the volume for, say, "The Oxford Book of English Prose". This is a great gift. It seems to arise from a natural ability to visualize clearly the type of mind of those addressed and to speak consistently in appropriate terms. Only once—and disastrously—does this power fail Mr. Hoyle, when, in the last few pages, he turns from the reader anxious to know and reflect on the present state of scientific thought in cosmogony and addresses him who is satisfied with the eschatology of Sankey's hymns. This part, however, could easily be omitted in a future edition.

Against these two merits must be set two defects: first, a certainty that the conclusions now reached must be right; and secondly (if it is indeed a separate foible), a conviction that there is not much more to learn. The scheme presented is frequently called "the New Cosmology", with even the adjective awarded a capital letter, and the evident implication is that there is no alternative, either present or to come. Take, for example, Chapter 4—"Origin of the Earth and the Planets". A process of formation of planets is described, not as a possibility but throughout as "the solution of the problem"; "this must have happened", and so on. The only hint of possible imperfection is introduced near the end—"This remnant of the parent of our planets is now almost certainly a faint white dwarf lying somewhere in the Galaxy". Why "almost", one wonders? A calculation of the number of other planetary systems follows: "I will admit that the last bit of this calculation is approximate" (this presumably means that it approximates less closely to the truth than the rest). "But even when full allowance is made for all the uncertainties I do not think that the final total could be less than 100,000. Our next question is . . ."

Not only are questions answered finally, but also, it seems, there are very few now left to answer. This kind of delusion has been common in all ages, and seems incorrigible. It was almost universal in the Middle Ages; Kepler was raised to the heights of ecstasy by it; then came Newton (who did not suffer from it), and the next century was its abject victim. "Astronomy," wrote Dr. John Hill in 1754, "is . . . a large and extensive field, but at this time greatly cultivated, so much indeed, that very few improvements can be expected to be hereafter made in it; very little being unknown of all that it proposes to teach." In our own time it is implicit in much of Sir James Jeans's writing—usually, however, com-

pounded for by a final sentence ("yet who knows how many more times the stream of knowledge may turn on itself ?") which could safely be trusted not to make any impression on the bewitched reader. In 1941 Prof. George Gamow wrote: "it may be hoped that in the course of the next few years a satisfactory solution of this last remaining puzzle of stellar evolution will finally be found". Now Hoyle proves that Jeans's theory is absurd and Gamow's is so baseless that "it now appears to have been abandoned even by its author".

What, then, of the future ? "Is it likely that any astonishing new developments are lying in wait for us ?" asks Mr. Hoyle, and he replies: "It may surprise you to hear that I doubt whether this will be so. . . . By and large I think that our present picture will turn out to bear an appreciable resemblance to the cosmologies of the future." One feels humbled in the face of such faith, beside which that of the 'fundamentalist' theologians seems child's play. Their beliefs have been held uninterruptedly for centuries and have never been disproved; why should they be tempted to doubt ? But Mr. Hoyle's conviction must sustain itself wholly from within; if he looks back on history, he sees certainty after certainty discredited and finality after finality surpassed. Yet undaunted he pins his trust for ever to the New Cosmology, "having seen she shall surely abide in the end". Even Tertullian could only say "certum est quia impossibile est"; Hoyle can say, "certum est quia improbabile est", and every theoretical physicist will acknowledge the greater triumph of faith over reason and experience. Nevertheless, if, as we may all hope, he is invited to broadcast on cosmology in forty years time, we suspect that it will be not only the audience that will be new.

HERBERT DINGLE

GRASSLAND FARMING IN GREAT BRITAIN

The Science and Practice of Grassland Farming

By Prof. H. I. Moore. (Nelson's Agriculture Series.) Pp. ix+166+21 plates. (London and Edinburgh: Thomas Nelson and Sons, Ltd., 1949.) 8*s*. 6*d*. net.

IT is generally agreed that, of the various ways of expanding food production in Great Britain, improved grassland practice offers the most substantial possibilities. This book comes at a very opportune moment in the national drive for higher production and brings evidence from many sources, as well as the experience and opinions of the author, to bear on the more recent and controversial developments.

All aspects of the subject are included, such as the historical background, grassland types, establishment of the sward, management, the economics of grass farming, conservation, diseases and insect pests of grassland, and finally seed production. A chapter on the constituents of grassland deals not only with the various species and strains of grasses and clovers, but also with the more desirable herbs. To many scientific workers and farmers, perhaps the most interesting chapters are those dealing with seeds mixture, the influence of the nurse crop and the correct grazing of the sward.

It is in these directions that—as well as conservation—hopes for major increases in production chiefly lie. The author brings the results of more than four hundred trials, carried out in Yorkshire, to bear on the problem of which is the best nurse crop, and whether the seeds mixture should be sown immediately after the cereal crop or after it has braided. Flax and linseed stand out as successful nurse crops, and the advantage of sowing the grass and clover seeds immediately after the nurse crop is obvious. On the question of seeds mixtures, readers can be forgiven for losing no time in turning the pages to find the author's views on the simple, two-component mixtures, sown for special purposes, which have a few but enthusiastic supporters. The author, however, does not commit himself as to whether these should supplant the older and more complex mixtures, and we have to agree with him that accurate feeding-trials are needed before a definite conclusion can be reached.

If a fault has to be found, it is that the book may be too comprehensive for some readers. Knowing the wealth of experience possessed by the author, it is difficult not to wish that he had expanded those portions dealing with the most recent studies of the establishment and utilization of the sward, and possibly omitted others, for example, the chapter on seed production.

A SOUTH AMERICAN ANTHROPOLOGICAL SYMPOSIUM

Handbook of South American Indians

Edited by Julian H. Steward. (Smithsonian Institution: Bureau of American Ethnology. Bulletin 143.) Vol. 5: The Comparative Ethnology of South American Indians. Pp. xxvi+818+56 plates. (Washington, D.C.: Government Printing Office, 1949.) 3 dollars.

IN the first four volumes of this work (see *Nature*, 158, 769; 1946; and 162, 908; 1948) the treatment is regional, and areas and tribes are described individually. The greater part of Vol. 5 is taken up with what is called a cross-cultural survey of South American tribes, in which various subjects are treated comprehensively, both in space and in time. All the articles were finished by 1945, and intense recent activity in some parts of the field has made some of them out of date; but this has been corrected to some extent by additions to the bibliography, and a further compensation is that the two valuable articles on basketry and weaving by Prof. L. M. O'Neale were ready before she died. Many aspects of material culture, social and political life, art, religion and learning are treated by the best authorities, including Bennett, Kroeber, Lowie and Métraux, and it will be very useful to have the information in this form. The editor himself disarms one criticism by directing attention to certain omissions, which were for various reasons unavoidable but which are nevertheless disappointing in so comprehensive a work. For example, the volume arrived just when I was looking for a particular piece of information about water transport; but unfortunately that is one of the subjects which are not included.

The next two sections of the book consist of a brief account of the Jesuit missions by Métraux, and a survey by the editor of population numbers, densities and trends. Finally, the editor contributes a summary of the South American cultures under the main headings used in the first four volumes, marginal

tribes, the central Andean peoples, and so on, in which he attempts to do for whole tribes and areas what the authors of Section I of this volume did for individual cultural features. He notes that socio-political and religious patterns suggest groupings which often differ from those indicated by purely cultural elements, and regards the former as the more significant. He ends the section with a brief history of the South American cultures.

This great Handbook is now nearing completion, and the extent of our debt to the editor and all concerned with its preparation is becoming apparent, though the effort involved strains the imagination. One volume remains to be published, and it is expected to deal with such important subjects as language, physical anthropology and early man.

G. H. S. BUSHNELL

STUDIES IN GREEK ARCHÆOLOGY

Annual of the British School at Athens

No. 44, 1949. Pp. viii+339+42 plates. (London: British School at Athens, 1949.) 63*s*. net.

THIS volume reflects fairly truly the current interests of British students of Greek archæology. The emphasis is on the early Iron Age, from the eleventh to the fifth century B.C., and particularly on its pottery, which is not only unusually varied and so (when properly classified) of the greatest help to excavators for dating their deposits, but also has a fashionable æsthetic appeal for the present generation of classical dilettanti.

The first contribution is a long report by J. K. Brock and G. M. Young on their excavation before the Second World War in the Aegean island of Siphnos. Excavation in Greece—and elsewhere—is often undertaken lightheartedly or for prestige rather than for knowledge, and the result is that evidence which may be unique is destroyed or suppressed. But here, though the early site had been badly disturbed by later occupation and some of the finds disappeared during the War, the excavators have done, and reported, their work conscientiously and well. The Aegean islands are one of the least understood areas of the early Iron Age in Greece, so that the choice of Siphnos was welcome. Though Brock has not and does not pretend to have solved the main problems of that area, he has made much more evidence available towards their solution. The individual finds are mostly unspectacular; noteworthy are a unique glass bowl of the Roman period with figures cleverly engraved on the outside so that they appear to be in relief, and parts of some large terracotta statuettes of the early seventh century B.C., which are made and decorated much as if they were pots—further evidence that sculpture proper did not begin among the Greeks until the middle of the seventh century.

The pottery of Corinth is already well classified: R. J. Hopper, in a long learned paper, dots and crosses some *i*'s and *t*'s. The most distinguished item is G. S. Kirk's explanation of the puzzling pictures of ships that are painted on some early Greek pots, especially those of Athens in the eighth century B.C. Kirk, who started with much knowledge of ships and none of archæology, decided not to rely on others and in a few weeks learned enough about early Greek art to distinguish for himself between pictorial convention and the representation of fact. The occasional stray from another field of archæology is the contribution by V. Milojčić, who re-examines the Neolithic cultures of Serbia and concludes that they owe much to influences from the south-east: the older view, now being widely abandoned, was that the influences passed in the opposite direction.

There are also short papers by Sir John Myres on a Minoan sealstone with an unusually long inscription in the undeciphered hieroglyphic script; by S. Benton on some pottery from Ithaca which she reclassifies as Early Iron instead of Late Bronze Age; and by R. M. Cook on the distribution of the pottery of Chios in the early sixth century B.C. O. A. W. Dilke adds three notes to his structural study of the Greek theatre. A. R. Burn writes light-heartedly about Mt. Helicon and how its geological structure has influenced history. A. M. Woodward proffers a scholarly note on the 'labyrinth' at Gortyn and its visitors in the fifteenth century A.D.

The volume is well printed and bound, and has fifty figures in the text besides its forty-two full-page plates; for those who are interested in its contents, it is good value for its price.

R. M. COOK

SUGAR THROUGHOUT THE AGES

The History of Sugar

By Noel Deerr. Vol. 1. Pp. xiv+258+20 plates. 50*s*. net. Vol. 2. Pp. xiv+259–636. 55*s*. net. (London: Chapman and Hall, Ltd., 1949–50.)

THE author of this comprehensive two-volume work on the history of sugar and the sugar cane is well known for his life-long connexion with this important crop and also as the author of "Cane Sugar", which has long been a standard work on the cultivation of sugar cane and the production of cane sugar.

In the first volume, introductory chapters deal with sugar as food for early man and the importance of honey in the Old World before the use of sugar became general, honey being known to have been of considerable importance to the ancient Egyptians and to some European peoples. The probable origin of sugar cane and its early distribution in other countries is discussed at some length. Separate chapters are then devoted to what is known of the early cultivation of sugar cane in such countries as China and the Far East, India, Persia, the Mediterranean countries; in the Portuguese, Spanish, British, Dutch, French and Danish colonies; and in the United States and the Hawaiian Islands.

The opening chapters of the second volume deal with the subject of slavery, which was so intimately associated with the early days of the plantation sugar industry in several countries. The author states in his preface: "I had not at first planned to do more than touch on the margins of slavery. As material accumulated it became evident that to write a history of sugar without at the same time treating of slavery was like trying to produce Hamlet with the part of Laertes omitted." These chapters, like those that follow on indentured Asiatic labour for sugar plantations, which has since led to racial problems in South Africa and elsewhere, should be of interest to the student of sociology as well as to those interested in the sugar industry and its early history.

Other chapters in the second volume are devoted to trade in sugar, refining, invention and research, beet and beet sugar, sorghum, maize, maple, skirret, locust bean and the mannas.

An interesting feature of the book is the number and varied nature of the illustrations. Many of these,

mainly wood-cuts, are taken from old and rare works on the sugar industry, dating back to the eighteenth century, which the author has been able to locate in the course of his researches in various libraries in Great Britain and the United States. There are also many portraits of the famous men of the sugar industry, some of which go back to very early times. Detailed references to literature are given at the end of each chapter, and there is a full index at the end of the second volume.

Although the literature on sugar and sugar cane is now very extensive, the present work constitutes a valuable addition, especially as it deals in so exhaustive a manner with an aspect of the subject which is either omitted or very inadequately covered in most books on sugar.

A SURVEY OF DERMATOLOGY

Modern Practice in Dermatology

Edited by Dr. G. B. Mitchell-Heggs. Pp. xxv+836+7 plates. (London: Butterworth and Co. (Publishers), Ltd., 1950.) 63*s*.

THE day of the one-man medical or surgical text-book seems almost done; it is, perhaps, a pity, but scarcely surprising. What is surprising is the high standard set by such books as the original Osler and Taylor's "Medicine", and in dermatology by the incomparable Darier's "Précis". Nowadays, the medical text-book is a compilation, not only by a number of practising clinicians but also by experts on ancillary subjects, such as zoologists, biochemists and geneticists. This is an obvious advance, although it is inevitable that the authors may express different opinions on the same subject and that the standard of their contributions may not be uniform. The editor of this book, Dr. G. B. Mitchell-Heggs, has on the whole chosen his team well. The majority belong to the younger school, and one feels confident that the future of dermatology in Great Britain is safe in their keeping.

As the editor points out, the book is neither a text-book nor a manual; and, although some chapters are devoted to single diseases, for example, those dealing with psoriasis, pityriasis rosea and syphilis, in others several dermatoses are considered together. In this latter category are: the distribution of dermatoses, such as disorders of the scalp, hands and feet, and ano-genital region; their causation, for example, diseases due to physical causes, fungus infection and to viruses; and the avitaminoses. The book is not meant to replace the standard manuals for students and general practitioners, or those written primarily for dermatologists, but "is designed to help practitioners, members of the Armed Forces and Government Services, and medical advisers to commercial organisations with international work, throughout the world".

In these days, it is necessary for dermatologists of all countries to study the diseases that are peculiar to or modified by hot climates, and for this reason the three chapters by Dr. L. J. Loewenthal are valuable. They describe the effects of heat and sunlight upon the skin, the peculiarities of the negro-skin, cutaneous myasis and onchocerciasis, certain fungus, protozoal, bacterial and virus diseases, the more important avitaminoses, prickly heat and mepacrine dermatitis. These chapters are clearly written and are essentially practical.

Since the monumental work of the late Dr. Prosser White, the importance of industrial diseases of the skin has become increasingly recognized, and, in a brief but authoritative chapter by Dr. Sibyl Horner, preventive measures are rightly stressed and discussed; and in a final paragraph is described the anxiety neurosis which is so often a sequel to industrial dermatitis and which leads to a superimposed neurodermatitis—"He worries and scratches and scratches and worries" puts the problem in a nutshell. The poor state of nutrition, which is mentioned as tending to heighten the susceptibility of the skin to external irritants, might have been discussed more fully, for there is considerable evidence that an excessive intake or diminished tolerance of carbohydrate, particularly sugar, and insufficient protein, favour an eczematous reaction.

Dr. Sibyl Horner's chapter must be read in conjunction with an admirable one on exogenic dermatitis by Dr. F. F. Hellier, who also emphasizes the psychological problem in industrial dermatitis, and with an intriguing one by Dr. David Harley on allergy. The last-named merits very careful study both by dermatologists and general physicians. Of particular interest is the section on bacterial sensitization, focal infection and the toxic focus. Dr. Harley considers that "many cases of so-called food-sensitization dermatoses are due to the effect of the food on an established intestinal infection, leading to increased production of bacterial allergens, which activate a bacterial-sensitization mechanism". In such cases the urticaria or other symptom does not usually develop until eighteen to twenty-four hours after the consumption of the suspected food, in contrast to the shorter period between consumption and onset of symptoms in a true food-sensitization.

He rightly draws a distinction between a direct toxic effect of bacterial products from some focus of infection, and allergic sensitization to such products. It is common experience that, in certain diseases of the skin and other structures that are clearly due primarily to focal bacterial infection, surgical removal of the focus or foci may be rapidly and completely curative, but has often only a partial or negative effect. The failures are explicable because the majority of the diseases in question are due to allergic hypersensitiveness to bacterial nucleo-proteins or endotoxins, which are not type-specific. Although the main focus or foci may have been removed, diffuse infection of mucous membranes, for example, of the throat or naso-pharynx, with the same or similar strains of organism may persist and supply sufficient allergen for the disease in question to continue. This consideration provides a strong argument in favour of desensitization by vaccine therapy, which, owing to ignorance of technique, has become unpopular. Dr. Harley, it should be noted, strongly supports the pathogen-selective method of Solis-Cohen.

Several other contributions would merit comment and discussion were space available, and, as examples of articles outside the usual range of the text-book, may be mentioned "Animal Diseases Transmissible to Man" by Dr. Sydney Thomson, "Arthropods in Relation to Skin Disease" by Mr. A. Fisk, "Psychosomatic Disorders" by Dr. W. J. O'Donovan, "Diseases of the Skin with Ocular Involvement" by Dr. Alice Carleton, "Biopsy" by Dr. J. H. Twiston-Davies, "The Pharmaceutical Aspect" by Mr. M. H. Payne, "Social Aspects of Dermatology" by Dr. M. Feiwel, and a very thoughtful article by the editor on "Cutaneous Manifestations of General Disease".

Standard Methods for Testing Petroleum and its Products

Tenth edition. Pp. lvi+660. (London: Institute of Petroleum, 1949.) 31*s.* 6*d.*

THE Institute of Petroleum is to be congratulated on the silver jubilee of this essential and now hardy annual, the original edition of which was published twenty-five years ago. When this tenth edition is compared with the previous (1948) edition, we find a number of changes, chief of which are the introduction of three new methods: an engine method of testing heavy-duty lubricants in relation to ring-sticking, wear and deposit accumulation; a method for research octane number of motor fuels; and a method for assessing the corrosive tendencies of cutting-oils in contact with cast iron.

Other methods have been amended as regards detail, particularly calorific value (now known as heat of combustion), distillation and viscosity. An important appendix (E) relates to a change it is proposed to make in future editions in regard to the "Precision Section". It has happened too often in the past, and in other "Standards" than this, that the terms 'repeatability' and 'reproducibility', as used to define 'precision', have been confused. What is now foreshadowed is that 'repeatability' of a method means the largest difference reasonably to be expected between duplicate results obtained by one operator using one set of apparatus in one laboratory *within a small interval of time* (my italics). The comment here is that the small interval of time must be defined, otherwise something is lacking in precision. 'Reproducibility' of a method is to be construed as the largest difference reasonably to be expected between single results obtained by two operators in different laboratories at widely different times. This latter is safe ground, providing counterpart samples are involved and 'time' determines no fundamental change in characteristics. Other standard-making bodies could well emulate this policy; let us clarify exactly what we mean by precision in all methods of test, irrespective of the nature of the materials concerned.

H. B. MILNER

The Birds of Tropical West Africa

With Special Reference to those of the Gambia, Sierra Leone, the Gold Coast and Nigeria. By Dr. David Armitage Bannerman. Vol. 7. Pp. xxxv+413+14 plates. (London: Crown Agents for the Colonies; Edinburgh: Oliver and Boyd, Ltd., 1949.) 55*s.*

DR. D. A. BANNERMAN is to be congratulated on having, with this volume, completed his systematic treatment of all the birds found in tropical West Africa. Only a volume of addenda has still to appear, this having been made necessary by the fact that publication has been spread over a period of twenty years, during which much further information on the subjects of the earlier volumes has accumulated.

Vol. 7 is entirely devoted to the weaver-birds. That a single family (plus one other species) should need so much space may seem surprising; but, in fact, nearly fifty genera and well over a hundred forms are found in the area. To give them their English names, they include weavers, bishops, whydahs, mannikins, negro-finches, seed-crackers, fire-finches, waxbills and others. In general, they are finch-like birds, often with brilliantly coloured plumage and sometimes with very long tails; many of them are familiar in aviaries. The tit-weavers, with slender bills, must be the smallest birds in Africa; the largest member of the family is the giant-weaver of São Thomé, some 8½ inches long.

The weaver-birds, of course, derive that name from the common habit of building beautifully woven pendent nests. In these, however, there is great diversity in pattern. Moreover, some species are solitary nesters and others build in large colonies—hundreds of nests on a single tree; in the extreme case the nests form a communal structure with connecting passages. The exceptions to the weaving habit include species which are cuckoo-like parasites upon others. Each species of the genus *Vidua* is parasitic upon a particular species in the genus *Estrilda*, belonging to the same family, and there is a remarkable parallelism between the plumage and mouth coloration of the young of the parasites and victims respectively. The aberrant cuckoo-weaver, on the other hand, is parasitic on the unrelated grass-warblers.

The production of the work, including the fine colour plates, maintains the high standard of the pre-war volumes.

A Source-Book of Biological Names and Terms

By Edmund C. Jaeger. Second edition. Pp. xxxv+287. (Springfield, Ill.: Charles C. Thomas; Oxford: Blackwell Scientific Publications, Ltd., 1950.) 32*s.* 6*d.* net.

HERE are arranged in alphabetical order well over twelve thousand elements from which present-day biological terms have been built up. Their Greek (transliterated into English), Latin or other origins are indicated, their meanings are concisely explained and many examples of their use in biological and other literature are given.

The three main types of names considered are: (1) generic names, usually derived from Greek stems; (2) specific names, generally derived from the Latin; (3) technical terms, derived from both these classical languages.

Students and teachers of biology should spend more time than they do in studying the meanings of the words and terms they use and their origin, for thus can they read real meaning into the words and eventually expedite and make more intelligible their reading of the technical literature. This book will help them to do so. Students and teachers would do well to possess a copy, and no biological library should be without it.

Gmelins Handbuch der anorganischen Chemie

Achte völlig neu bearbeitete Auflage. System-Nummer 68: Platin. Teil A, Lieferung 5: Die Legierungen der Platinmetalle; Ruthenium, Rhodium, Palladium. Pp. vii+533–718. (Clausthal-Zellerfeld: Gmelin-Verlag G.m.b.H., 1949.) 43 D. marks.

THE present volume of this well-known work deals, in the usual complete and detailed way, with the physical and mechanical properties of the alloys of ruthenium, rhodium and palladium. Some of these alloys are of technical interest. It begins at p. 533, so that earlier parts, not available to the reviewer, must have appeared. Those who are familiar with the general character of "Gmelin" will know how well the subjects are dealt with, and this part will have an interest to metallurgists as well as chemists.

J. R. P.

UNITED STATES SCIENCE OFFICES ABROAD

By Dr. C. E. SUNDERLIN*
U.S. Office of Naval Research, American Embassy, London

PLANS for United States Science Offices at home and abroad are proposed in the extensive report entitled "Science and Foreign Relations" recently submitted to the State Department by Dr. L. V. Berkner, of the Carnegie Institution. Included in the principal recommendations of the report are proposals for the establishment of Science Offices in the capitals of various foreign countries; the creation of a Science Office in the State Department in Washington; the integration of scientific and technological points of view with planning in the fields of economics, politics and public affairs; and closer co-operation of United States science with foreign policy-making by the State Department.

Dr. Berkner was assisted in the preparation of his report by the State Department International Science Policy Survey Group, which consisted of members drawn from various governmental and non-governmental organisations such as the State Department, the Research and Development Board, the Department of the Navy, the Interdepartmental Committee on Scientific Research and Development, the National Research Council, etc. A special Advisory Committee on International Science of the National Academy of Sciences reviewed the report and unanimously approved it in principle before its final submission to the Secretary of State. This Advisory Committee on International Science consisted of Prof. Roger Adams (chairman), Dr. Vannevar Bush, Prof. I. I. Rabi, Dr. Alexander Wetmore, Dr. R. E. Wilson, Prof. D. W. Bronk and Dr. A. N. Richards. In addition to the individuals constituting the State Department Policy Survey Group and the Advisory Committee on International Science of the National Academy of Sciences, a large number of governmental agencies and individuals from both public and private life contributed in various ways to the preparation of the final report. It is estimated that more than one thousand individuals participated in the work of the survey group.

The establishment of a Science Office in the Department of State is one of the key recommendations in the Berkner report. This Science Office would have the following general functions: (*a*) to provide supporting operations for science staffs in United States scientific missions abroad; (*b*) to carry on liaison with domestic scientific activities; (*c*) to review and advise on policy and administration decisions as they relate to, or affect, science and technology; (*d*) to evaluate the effectiveness of programmes and policy in the light of progress and potentialities of science and technology. In order to accomplish these purposes it is proposed that the Science Office be established at the policy-level in the State Department.

The head of the proposed Science Office would be a "science adviser", appointed as special assistant to the Under Secretary of State. He would be assisted by a small staff consisting of a deputy and three other men of science representing, respectively, the physical, biological and engineering sciences. In addition, there would be a Scientific and Technological Information Branch of the Science Office in order to co-ordinate scientific and technical information requirements. The war-time experience of the Office of Scientific Research and Development has indicated the necessity for such a central information office in Washington.

In order to integrate the activities of the Science Office with those of the political, economic and public affairs areas of the State Department, liaison members from these areas will be assigned to the Science Office. In like manner, because of the continued interest and participation in international scientific relations by other governmental agencies, liaison members from these other agencies will also be assigned to the Science Office. It is stated explicitly in the report that the Department of State should not interfere with the international scientific relations activities of other government agencies. However, the Department should be apprised of the general scope and nature of these activities so as to measure their effect on the overall conduct of United States foreign relations.

Sections in the National Science Foundation Act of 1950, which was recently enacted by Congress, provide that the Foundation shall be authorized to co-operate in any international scientific research activities consistent with the purposes of the Act, and to foster the interchange of scientific information among men of science in the United States and foreign countries. The Berkner Report recommends that a liaison officer from the National Science Foundation be permanently associated with the Science Office in order to ensure effective servicing of the Foundation's requirements.

The pattern suggested for Science Offices in other countries is unique. The fact is clearly recognized that certain functions of a Science Office must pertain to scientific relations with the particular country in which the Office is situated. Equally clearly the oft-repeated statement that science knows no geographical boundaries has been taken into consideration. In order to obtain the highest calibre of scientific worker for service in Science Offices abroad and to make maximum use of his abilities, certain functions should be on an area basis rather than on a country basis. A scientific worker in the pursuit of his special field of interest should not in general be restricted in his activities by the geographical boundaries of a single country. Important work in biology is in progress not only in Great Britain but also in France, Italy, Denmark and elsewhere. Fundamental metallurgical research is in progress in Britain, Belgium, Austria, Sweden, Germany, etc. Centres of research in cosmic ray physics are situated in Bristol, Manchester, Paris, Rome, Amsterdam, and at the Jungfraujoch. It is proposed, therefore, that two categories of Science Office be established. Offices in Category 1 will consist of staffs whose functions relate to general geographical areas such as Western Europe, the Middle East, South America, Australasia, etc. Science Offices in Category 2 will consist of staffs which are primarily concerned with functions relating to the particular country in which they are located. A Science Office in Paris, for example, might be concerned with those scientific relations which primarily concern the United States

* The statements made in this article are the responsibility of the author and not of the U.S. Navy or the U.S. Department of State.

and France: the Fulbright and Smith–Mundt programmes in France, the technical assistance programme of E.C.A., the Point IV programme as it might apply to under-developed areas in French colonial possessions. Because of the fact that the secretariat of Unesco is located in Paris, the Paris Science Office might be expected to establish close working relations with that Organisation.

The initial proposals for the establishment of Science Offices in both Categories are as follows.

Category 1 (Area Offices): Western Europe, London; South Africa, Johannesburg; South America, Rio de Janeiro; Australasia, Sydney (or Canberra).

Category 2 (Single Country Offices): Paris, Brussels, The Hague, Rome, Berne, Stockholm, Oslo and/or Copenhagen, Lima, Ottawa.

The area office in London would have the dual function of geographical coverage of Western Europe in the various special disciplines of science and also the Category 2 functions as they pertain to matters of direct concern between the United States and the United Kingdom. The early establishment of area offices in Cairo and New Delhi is to be considered. The establishment of other Category 2 offices may be anticipated in South America, Africa, etc., after the area offices have been set up.

The establishment of Category 2 offices in Germany and Japan poses special problems which will be worked out in consultation with the United States High Commissioner for Germany and the Supreme Commander, Allied Powers in Japan.

The Category 2 offices which are to be established in capitals of various countries will, in general, consist of scientific staffs comprising one to three scientific workers. No general recommendation is made as to the size of the Category 1 or area offices; the present arrangement in the American Embassy, London, may give some clue as to the eventual size of these offices. At the present time the London Science Staff of the State Department consists of two men of science whose activities are essentially those of a Category 2 office. The Office of Naval Research, London, comprising ten to twelve men of science, exercises Category 1 or area office functions in its activities in Western Europe. The combined activities of the London Science Staff and U.S. Office of Naval Research, London, might furnish a pattern for the other area offices which are proposed in the report.

The functions to be performed by science staffs of both Categories 1 and 2 would cover the following: "reporting on significant trends and developments in foreign science; encouragement of collection and transmittal of foreign scientific and technical information to the United States by private individuals and organisations (public and private); actual collection and transmittal where the situation does not readily permit of direct access between such United States individuals and the foreign sources; advice to the chief of the United States mission and his staff on scientific matters; representation and maintenance of the interest of United States science and scientists abroad; response to the scientific requirements of all United States Government agencies; assistance to both United States and foreign scientists in the procurement of scientific apparatus, chemicals, biologicals, and other scientific tools and materials; arrangement, when appropriate and desirable, for collaborative research projects between United States and foreign scientists; the implementation of the flow of scientific information on a two-way basis; and the facilitation of arrangements for visits of United States scientists who may be travelling abroad".

It is fully realized by those who participated in the formulation of the report that the science staffs must encourage in every way two-way exchanges of scientific information and of scientific workers. As it states in the report, "experience clearly shows that the flow of information must be a cooperative enterprise".

The importance of science and technology in national affairs and international relations, particularly during the present period of rehabilitation, has been indicated in various ways. On the national scale one might point to the establishment of high-level scientific advisory groups in Great Britain, such as the Advisory Council on Scientific Policy, the Defence Research Policy Board, and the Committee on Industrial Productivity. On the international scale one could cite in the United States the work of the Division of International Relations of the National Research Council, the National Commission for Unesco, and the various educational exchange and technical assistance activities, such as the Fulbright, Smith–Mundt, Point IV, and E.C.A. programmes. The proposed Science Offices which would be established in various countries of the world could assist the agencies of the United States Government in such international programmes as are listed above.

The active participation of the National Academy of Sciences and the National Research Council in the work of the Science Office is expected after the last-named has been established. It is recommended in the Report that the State Department urge the National Academy of Sciences to appoint a committee of eminent United States men of science which would act as a top-level board in advising the Department concerning scientific and technological questions. The National Research Council has indicated that it would be glad to assist, through its Division of International Relations, and through appropriate organisational changes, in strengthening co-operation between the State Department and the scientific workers of the nation.

The Report submitted by Dr. Berkner has been accepted by the State Department. The selection and appointment of a science adviser may be expected in the very near future. Following his appointment, the establishment of the Science Office in the State Department and of the Category 1 and Category 2 Science Offices in other countries will follow in due course.

PHYSICAL CHEMISTRY OF DRUG ACTION

A SYMPOSIUM on "Physical Chemistry of Drug Action" was arranged jointly by the Royal Institute of Chemistry and the Society of Chemical Industry, and held in University College, London, on April 19.

In opening the symposium, Sir Cyril Hinshelwood pointed out that two distinct fields had to be explored: how the drug reaches the seat of action and what it does when it gets there. Various physico-chemical principles have been shown to govern the action of various drugs. The laws of physical

chemistry must apply to such reaction systems just as they apply to all non-living reaction systems.

Because of the elaborate nature of the mechanisms by which foreign substances become distributed in the higher animals, questions of access to the site of action are best studied in single-celled organisms. The question is often raised as to whether the permeability of the cell wall determines the action or whether equilibrium between the cell and the medium can be assumed. Arsenic-resistant trypanosomes, unlike sensitive trypanosomes, are unable to accumulate the arsenical from the medium, and penicillin is able to hinder the uptake of glutamic acid by cells. But penetration is by no means always the limiting factor. The time taken by proflavine to arrest the growth of *B. lactis aerogenes* is independent of the concentration gradient between the inside and outside of the cell. In fact, cells trained to be resistant to proflavine take up appreciably more of the drug than before the adaptation. Again, the influence of many inhibitors on the growth-rate of bacteria is independent of pre-treatment for periods amply sufficient for the establishment of even a sluggish equilibrium. Again, cells are freely permeable to sodium; but potassium is taken up preferentially and sodium scarcely at all. Hence penetration and accumulation are two very different things. When permeability is not the limiting factor, a further question arises: Is a simple partition between two phases involved, or an adsorption equilibrium? Perhaps, with the complex macromolecular networks involved in cells, something between solution and adsorption must be envisaged.

As to the mode of action of the drug at a given locus, various mechanisms have been demonstrated in different cases. In some cases, the effect is not directly dependent on the chemical constitution of the molecule. Ferguson has shown that numerous substances, from phenols to the rare gases, have approximately equal narcotic actions when present in the tissues at equal fractions of saturation.

However, the subtly differentiated kinds of physiological action involved in chemotherapy are usually highly dependent on structure. In some cases, ionization constants are determinative; in others it is the ability to form co-ordination compounds with trace-metals. In yet others, covalent bonds may be formed with specific groups such as —SH; in others the action depends upon a steric resemblance between the drug and some essential metabolite.

In the matter of predicting relations between structure and biological action, too much should not be expected of physical chemistry. Nevertheless, its value for supplying rational interpretations is considerable, and knowledge of these can be used for modifying the drug molecule so as to improve its action.

The network of normal metabolic reactions taking place in a cell is often cyclically linked and contains many competing reactions. The kinetics of these processes are being intensively studied in the presence and absence of inhibitors, and the results are likely to make a distinct contribution to our knowledge of drug-action.

In conclusion, physico-chemical principles provide a rational system in terms of which we may, and indeed should, envisage the relations of cells to those foreign substances that gain access to them: but we must not look for a simple all-embracing formula.

Prof. F. A. Paneth spoke on the use of tracer elements in pharmacology. Because any element and its isotope can be relied upon to remain together during chemical reactions, the use of isotopes as indicators in tracing the distribution of a drug may offer advantages over other methods. Actually, it is often the only feasible method. The more complicated the system to be studied, the clearer is the superiority of this indicator method. This explains why the most extensive use of isotopes is found in the biological sciences.

In studying biological processes, it is safer to use inactive (rather than radioactive) tracers. Even small activities have been known to exert a marked effect on biological processes. Unfortunately, mass-spectrographs which will measure small, practicable amounts of inactive tracers (such as 0·001 c.c. of nitrogen-15) still remain to be developed. The measurement of such quantities of radioactive material is, on the other hand, quite simple. In Britain we have very few kinds of inactive isotopes, principally carbon-13 in the form of barium carbonate and oxygen-18 in the form of water. However, other kinds would be available before long, as in the United States.

The radiochemist has an exacting task in preparing substances for studies of drug action (cf. *Quart. Rev. Chem. Soc.*, **2**, 93; 1948; *Nature*, **163**, 388; 1949) and for analyses by the isotopic dilution method. First of all, a drug must be chosen which can be recovered from biological material in a pure state, either as such or as a well-defined breakdown product. The synthesis of an isotopic form of this drug must then be undertaken. If the isotope has a short lifetime, it is better to choose the most rapid synthesis even though a lower weight of pure product can be obtained by this route. It is usually the chemist's duty to work with the strongest obtainable concentrations of isotopic material and to present the biologist with substances of the highest possible specific activity. In support of this statement, it has been shown that, in one case, a sample of iodine of low specific activity had to be used in such a high dosage that a strong pharmacological effect was elicited and the experiment completely spoilt.

It is not always convenient to set up an isotopic chemical department in a medical school. Hence it is worth noting that the Radiochemical Centre at Amersham is willing to consider the synthesis of isotopic substances to order. 'Isotope farming' provides a very useful method for synthesizing isotopic specimens of the more complex molecules associated with living processes. This is accomplished by supplying the desired fungus, animal or higher plant with isotopically charged foodstuffs or gaseous carbon dioxide from which it then synthesizes isotopically labelled material. In this way, isotopic casein, sugars, digitalin and penicillin have been obtained. Isotopic farming can also provide a useful means of disposing of residues of carbon-14.

Because iodine becomes concentrated in the thyroid gland, cancer of the thyroid can be treated orally by radioactive iodine. This is not yet a method of general utility for treating other forms of cancer because no organic or inorganic substance that will concentrate in cancerous tissues is known. When such a substance is found, it can readily be made radioactive and hence should prove specifically destructive to the cancer. For the present, the principal value of artificial radioactive substances in pharmacology lies in their use not as drugs but as indicators of the mode of action of drugs.

Dr. H. R. Ing discussed the effect of size and shape of drug molecules upon drug action. The idea of

'fit' between biologically active molecules and the biological structures upon which they act goes back to Pasteur and was used by him to explain the stereo-specificity of enzymes. It has since been extended by Landsteiner to give a satisfactory explanation of the antigen-antibody reaction and by Michaelis to develop his postulate of an enzyme-substrate complex, a hypothesis now widely accepted. Studies of the interaction between a drug and its biological receptor have much to gain from this concept of 'fit'. A good physical basis for it exists in the Van der Waals forces and in hydrogen-bonding. Van der Waals forces, being both weak and of short range, are consistent with what is known of the stereo-specificity (as well as the ready reversibility) of drug-receptor bonding. To be held by these forces, molecules must come into intimate contact at numerous points: thus the drug molecule must be of such a shape and size as to accommodate itself closely to the biological structure (for example, enzyme or cytoplasmic membrane) on which it is to exert its disturbing effect. The experimental approach to spatial relationships must be confined, at first, to fairly simple molecules.

The best approach to the function of shape, in isolation, can be found in the study of isomeric drugs. The usual lack of competitive antagonism between optical isomers is informative, as is the lack of competition between sulphanilamide and the *o*- and *m*-isomerides of the highly competitive *p*-amino-benzoic acid. Two isomeric cations which have approximately the same volumes but very different shapes are $(C_2H_5)_4N\oplus$ and $(CH_3)_3N\oplus C_5H_{11}$; the former, but not the latter, exerts a strong paralysing action on the neuromuscular junction.

Some of the simplest examples of the importance of shape are provided by pairs of optical enantiomorphs. *l*-Adrenaline is ten to twenty times as active as *d*-adrenaline in increasing arterial blood pressure. Clearly, the low activity of the *d*-isomer is due to its low affinity for receptor sites. By a systematic stepwise modification of the adrenaline molecule, it can be shown that the *l*-isomer forms three attachments to the receptor, using three groups (phenolic —OH, alcoholic —OH and —NH) which are capable of forming hydrogen bonds (or the —NH group may be engaged by an ionic bond). *d*-Adrenaline is able to form only two of these bonds, and further evidence indicates that the alcoholic —OH of this isomer is too remote from the appropriate group on the receptor to make effective contact with it.

By continuing these stepwise variations, it has been shown that the *m*-OH group is more important than the *p*-OH, because omission of the latter gives a substance, 'neosynephrin', the *l*-form of which has one-third of the activity of adrenaline.

The effect of shape can be followed in acetylcholine

$$CH_3COOCH_2CH_2X\oplus Me_3 \qquad (I)$$

(I, $X = N$) and its analogues where $X = P$ or As. When nitrogen is replaced by phosphorus, the activity falls to one-twelfth, and replacement by arsenic lowers activity to one-eightieth. These differences in pharmacological effect can be shown to be due to the size of the cationic head, namely, the hetero-atom plus the methyl groups which it carries. The larger the hetero-atom the more the methyl groups are extended into space to occupy the volume which three ethyl groups on a nitrogen atom (a combination with only feeble activity) would normally occupy. From these and other experiments in varying the shape of the acetylcholine molecule, it would appear that two methyl groups of this hormone have to fit on to fixed receptors in the effector-cells. Any change in the distance between them will be reflected in the lowered activity of the molecule.

Both shape and size have been varied, independently and together, in a stepwise exploration of the antibacterial properties of certain planar cations of the acridine, benzacridine, quinoline and benzquinoline series and their non-planar hydrogenated analogues (cf. *Brit. J. Exper. Path.*, 30, 159; 1949). This work has led to a clear understanding of the minimal spatial requirements for activity in this series of drugs.

These intimations of the importance and nature of 'fit' between drug molecule and biological structure are beginning to illuminate otherwise puzzling structure-action relationships.

Prof. Adrien Albert spoke on ionization—an important factor which is sometimes critical. Many biologically active substances respond to a change in *p*H by a change in their degree of ionization. Conversely, if the *p*H is held constant, closely related substances, even isomers, ionize to widely different extents. The importance of these data lies in the fact that the ion and the neutral molecule of a given substance have different degrees of biological activity in all cases that have been investigated. Sometimes these differences even partake of an all-or-nothing character. Chemistry provides many examples that help us understand how an ion and a molecule of the same substance can elicit different biological responses.

(i) Chemical reactivity in the bulk phase is often dependent on the degree of ionization. Dimethylaniline becomes nitrated in the *para* position, but its ion undergoes *meta* nitration. Again, the uncatalysed autoxidation of ascorbic acid proceeds through the divalent anion, but not when catalysed by copper, which permits only the monovalent anion to be attacked.

(ii) Adsorption at surfaces is not indifferent to ionization. In non-specific adsorption (where the molecule has a highly polar/non-polar structure) the neutral molecule is the more highly adsorbed; but in the specific adsorption from water of well-hydrated molecules, the ion is frequently preferred.

(iii) The penetration of membranes is effected much more readily by a molecule than by its corresponding ion, principally because of the surface-charge on the membrane. However, ions can be made to penetrate natural membranes by increasing the proportion of lipophilic to hydrophilic groups.

Ionization is an essential condition for the action of certain drugs. The cationic antibacterials of the acridine, phenanthridine and benzquinoline series are cases in point. Regardless of the type of substituent (for example, amino-, diamino-, methyl-, chloro-) present, the important condition is that these substances should be ionized at *p*H 7. Hence, in these series, one can make numerous pairs of isomers, of which one is ionized and the other is not; the ionized one is always found to have high antibacterial activity, whereas the non-ionized substance has little or none.

For some other drugs, particularly weak acids, ionization is highly disadvantageous. The action of phenylarsenoxides on the spirochæte of syphilis (Eagle, 1945), of barbiturates and local anæsthetics on *Arenicola* worms (Clowes and Keltch, 1931), of

salicylic acid on echinoderm division (Smith, 1925) are examples where the ion is entirely or almost entirely inactive.

A number of drugs, particularly the alkaloids and local anæsthetics, have *p*K values between 6 and 8. This means that at physiological values of hydrogen ion concentration (around *p*H 7), both ions and neutral molecules are present in a ratio lying between 1 to 1 and 1 to 9. Such drugs can pass through membranes which would exclude ions and yet can regenerate some ions (by mass action) on the far side of the membrane.

From these and other examples, it is clearly important to know the ionization constants of all biologically active substances under investigation. Such knowledge should then be used to decide whether ion or molecule is the more active. This is done in two complementary ways: (i) by varying the *p*K of the drug through appropriate substitution, keeping the *p*H of the biological medium constant; (ii) by keeping the composition of the drug constant and varying the *p*H. Such information can materially shorten the time taken to find the most active substance in a given series, because it brings one of the commoner variables completely under control.

Drs. H. J. Barber, F. Bergel, T. McLachlan, B. A. Pethica, M. A. Phillips, D. Ridge, J. H. Schulman, R. Slack and H. I. Stonehill took part in the discussion.

ADRIEN ALBERT

OPERATIONAL ANALYSIS AND THE NATURE OF SOME PHYSICAL CONCEPTS

THE Philosophy of Science Group of the British Society for the History of Science, under the chairmanship of Prof. J. H. Woodger, held a meeting on May 5 at University College, London. A general discussion took place on questions arising out of Prof. P. W. Bridgman's three lectures on "The Nature of Some of our Physical Concepts" delivered at University College during April 24–28. (These lectures are to be published in the *British Journal for the Philosophy of Science*.) The meeting was attended by about forty members of the Group and visitors.

Prof. Bridgman opened the discussion with a brief summary of his lectures. He thought that their most important feature was the detailed analysis of how the operational technique can be applied to specific physical concepts and problems. In the first lecture, he had discussed general concepts such as field, action at a distance, and empty space; in the second, thermodynamical phenomena, in particular the laws relating to energy and entropy; and in the third, some situations presented by thermo-electric phenomena. Prof. Bridgman believed that the particular novelty of his analysis in these lectures was the self-conscious separation of physical operations into those of an instrumental character and those of a 'paper-and-pencil'—that is, mental—character. He had been aware of this distinction for a long time, but only recently had he seen how it applied to what physicists actually do. With regard to this, there are two points of view, as follows.

Instrumental operations correspond most nearly to what used to be called 'physical reality'. This aspect of physics can be illustrated by an analysis of the field concept. Instrumentally, the existence of a field at a certain place means that, if you go there with the appropriate type of instrument, it will record a certain 'reading'. Similarly, in applying the first law of thermodynamics, one must specify the elements of space, and in particular their boundaries, on which one operates, so that the fluxes over these boundaries correspond to the actual instrumental readings.

The other aspect relates to the way in which our verbal demands interlock with our instrumental operations. For example, we accept the typical conservation laws of physics as verbal guides with rational implications, but we also find that there exist instrumental operations corresponding to our verbal demands.

It is Prof. Bridgman's belief that, in general, no sharp dividing line can be drawn in physics between the purely instrumental and the purely mental. He regards the whole operational approach as part of a larger programme, according to which we regard the world about us in terms of 'activity' rather than picturing it statically. From this point of view, it is preferable to describe our theories in terms of what we 'do' rather than in terms of 'things'.

Prof. H. Dingle said that, although he is in general agreement with the operational point of view, he attaches less importance than Prof. Bridgman to the distinction between instrumental and paper-and-pencil operations. He prefers to emphasize instead the distinction between those concepts which are associated with measurements, usually denoted by symbols in our equations, and those, such as action at a distance, empty space, etc., which we employ 'pictorially'. He thought that this differentiation is important because we should confine our operational analysis to concepts of the former type, as he has already explained in some detail in his presidential address to the Group in March 1949 (*Brit. J. Phil. Sci.*, **1**, 5; 1950). Prof. Dingle considered that one of the most important applications of the operational principle concerns the separation of the actual experimental results from the theoretical concepts used in visualizing them. As an example, he directed attention to a well-known method of determining the wave-length of monochromatic light by means of a diffraction grating. The fundamental equation can be written as $d \sin\theta = m\lambda$, as explained in standard text-books. Operationally, the numbers d, θ and m (spectrum number) can be directly determined; but the fourth number λ, the wave-length, is never measured directly, that is, from crest to crest. Hence, the operational content of this equation is confined to the invariance of the quantity $d \sin\theta/m$ for different values of d, θ and m. If we wish, we can denote this invariant by the symbol λ. So far, no picture of this invariance need be formed. If, however, we appeal now to theory and regard light as consisting of trains of waves, we can give a theoretical interpretation to λ as a length; whereas, if we regard light as consisting of corpuscles, we can interpret λ as a constant of the dimensions of action divided by momentum. We are at liberty to use any picture we find satisfactory, provided that λ has the correct physical dimensions. The function of such pictures is to stimulate and guide research, to facilitate the mental grasp of the situation, and ultimately to disappear in favour of better ones. These functions are not assisted but rather hindered by the demand that the details of the pictures must satisfy the operational criterion.

Turning to a point of detail, Prof. Dingle said that he had not been convinced by Prof. Bridgman's argument that energy can be located, as it appeared to be at variance with Prof. Bridgman's own demonstration that light cannot be located in transit, but only at points of emission and absorption.

Prof. Bridgman said that he regarded λ as having a larger instrumental component than Prof. Dingle had indicated. He thought that Prof. Dingle had considered this particular question from too narrow a point of view and had omitted the fact that a definite λ is to be correlated with a definite source. The same source can be used for many other experiments, for example, diffraction, Newton's rings, etc., yielding the same λ. This invariant would then be regarded as a fundamental characteristic of the source having not only paper-and-pencil, but also instrumental, significance. We can both usefully calculate with λ as a constant in theoretical work and also connect λ with the instrumental specification of the source. Consequently, he thought that in a wider setting Prof. Dingle's sharp distinction between the instrumental and the mental components would become blurred.

With regard to the specific question about energy and light, Prof. Bridgman remarked that he was glad to have the opportunity of disowning his former view, expressed more than twenty years ago in his book "The Logic of Modern Physics", that energy is not localized. He thought that the localization of energy in a beam of light becomes possible when we can determine the microscopic *E*- and *H*-vectors in the beam as they vary during a period, and can thus determine the fine-scale Poynting vector.

The question came from Mr. C. C. L. Gregory, who inquired about the application of operational analysis to the interior of stars. In view of the practical difficulty of determining temperatures, etc., in such regions, he asked if we ought to regard the subject of stellar structure, at least in so far as it relates to internal constitution, as wholly of a paper-and-pencil character. More generally, he wondered whether physicists do not often assume implicitly that operations can be done instrumentally which, in fact, cannot be so done. He also wondered whether the whole concept of change does not entail difficulties as regards the application of our paper-and-pencil concepts. Certainly, we seem to base physical theories as far as possible on conservation laws which correspond to essentially mental demands.

Dr. G. J. Whitrow agreed that we often tend to regard certain impracticable instrumental processes as possible 'in principle' when, strictly speaking, they are not even that. In Prof. Bridgman's discussion concerning our inability to distinguish instrumentally between the concepts of field and action at a distance (with the conclusions of which he fully agreed), he thought that just such an example had been introduced. It has been suggested that gravitational force, whether due to a field or to action at a distance, can in principle be detected instrumentally in a region midway between the earth and the sun. He thought that there is a difficulty here, over and above that arising from the inaccessibility of such a region. In time such a region may cease to be inaccessible, but, unless special precautions can be taken, the instrument concerned will be influenced in the same way as the actual test-mass to be introduced in this region and so will give no 'reading'. The necessary precautions for counteracting the gravitational effect on the instrument can, of course, be taken on the (almost) rigid surface of the earth, but he thought that in inter-planetary space the situation is very different. In general, he considered that the farther one goes from terrestrial laboratories, etc., the more predominant becomes the paper-and-pencil technique in physics, while the instrumental element tends to be restricted to kinematical rather than dynamical phenomena. In reply, Prof. Bridgman said that he had, of course, intended that the instrument used should be 'anchored' to the sun, and he thought that no difficulty arose in principle. Dr. Whitrow considered that this was so impracticable that he found it difficult to imagine that any instrument could be effectively shielded against the gravitational influence of the sun. In subsequent discussion, Prof. K. R. Popper suggested that a proper platform for the gravitation-indicating instrument could in principle be provided by a rocket so controlled as to be moving with uniform velocity relative to the sun.

Dr. W. Ehrenberg asked whether the view that energy is localized would imply that the field concept is right and action at a distance wrong. Prof. Bridgman thought that in any given case a problem such as this can only be answered by carrying out an analysis which will show in detail what the localization is. With regard to gravitation, he thought that the energy can consistently be located in the massive bodies, just as an alternative mathematical method of localizing electrostatic energy is in the charges. If there were not a magnetic field surrounding an electrostatic charge in motion, there would be no Poynting vector. The magnetic field about a moving charge is so small that it is difficult to detect instrumentally when charges are displaced, and until it was discovered energy had to be localized in the charges. But with the discovery of the mere existence of this very small effect, the picture changes qualitatively, and we now visualize the energy as diffused throughout space. A perfectly consistent picture of the localization of gravitational energy in the masses can be built up.

In reply to a question by Dr. E. H. Hutten, concerning entropy and irreversible thermodynamic processes, Prof. Bridgman said that bodies exist for which every departure from a given configuration is irreversible. He has posed the problem of inventing a generalized entropy function which would be universally applicable and would continually increase for the universe. Dr. Hutten agreed that in Nature there are no truly reversible processes, and that, strictly speaking, the classical entropy concept applies only to abstract processes.

Concerning the fundamental question of the meaning of operational analysis, Dr. Hutten thought that it is important to distinguish between thought-experiments which are essentially of a paper-and-pencil character and others, for example, those relating to the far side of the moon, which are only so because of our present technical limitations. He suggested that, on the lines of the traditional 'synthetic–analytic' division of thought, we should describe the division now contemplated as 'semantic–syntactic'. Prof. Bridgman, however, did not favour a rigid division, and gave it as his opinion that one must work in a laboratory in order to understand fully what operational analysis is.

It was suggested by Dr. M. D. H. Strauss that there are two main uses of operational analysis, namely, for clarifying a given theory, and also for helping to delimit the field of application of a theory. Often a restricted domain of phenomena can be

described theoretically in a number of different ways which are operationally equivalent, but when a wider domain is considered some of the competing theories will tend to be discarded. Maxwell's equations, for example, are not applicable to the elementary particles. Prof. Bridgman said that his own remarks concerning these equations applied only to ponderable matter. He thought that, when attempting to construct general theories in physics, it is a mistake to be dominated by fixed intuitions. In his opinion, Einstein made a mistake of this kind in constructing his generalized theory of gravitation, for his point of view was dictated by his intuition concerning the universal application of the field concept.

Mr. L. L. Whyte thought, however, that one of the main functions of operational analysis is its use in clarifying basic principles in physics with the object of extending their field of application. Einstein and Heisenberg, for example, each made a kind of operational analysis directed to differentiating between the measurable and the inherited mental components in certain branches of physics. Their work was essentially positive and creative, for they discovered elements in our thought which were inessential. Our thought became more powerful when these elements were discarded. On a point of detail, Mr. Whyte said that he believed that a thoroughgoing operational analysis should be made of the concept of time in quantum physics. A direct appeal to time is not usually made in determining, say, the velocity of an electron, although in recent work with electron tubes direct time effects are observed. Prof. Bridgman agreed that this whole question ought to be analysed much more fully than it had been hitherto.

In reply to a further question by Mr. Whyte, Prof. Bridgman said that he had worked on high-pressure physics before he began to study operational analysis. This study arose out of a distinct response to his own personal experience; it grew out of his essay on dimensional analysis. It was greatly stimulated by his being suddenly called upon to give a course of lectures on electrodynamics, and so being confronted with the need to think matters out anew for himself.

G. J. WHITROW

ANTIBIOTICS IN THE SOIL

By DR. A. C. THAYSEN

Colonial Microbiological Research Institute, Trinidad

IN his presidential address in 1949 to the British Association on the subject of world population and world food supplies, Sir John Russell[1] referred to certain observations made during the year on the isolation of antibiotic-producing organisms from tropical soils[2]. Russell suggested that it might eventually become possible to control some soil-borne plant diseases by introducing or encouraging micro-organisms with appropriate antibiotic properties to grow in infected soils.

This stimulating thought, could it but be put into practice, would at once raise the subject of antibiotics from what Conn[3] described as an interesting, though not an agricultural one, to one of deep agricultural significance and therefore of great interest to soil microbiology. But before such preventive measures could be successfully undertaken, a much better understanding would have to be acquired, not only of the occurrence of antibiotic-producing micro-organisms in soils and in their other natural habitats, but also of the conditions—if they can be shown to exist—under which their activity is favoured.

Without wishing to belittle the efforts made hitherto, it is probably not exaggeration to say that, until quite recently, workers interested in antibiotics concentrated their energies on detecting new types of organisms producing them; on determining the chemical structure of the isolated antibiotics; and on applying the pure or purified substances in combating human and animal infections. Little attention was paid to the natural habitats of micro-organisms with antibiotic properties, or to their functions within these habitats. An exception should be made in the case of Nakhimouskaia's observation[4] that, as quoted by Waksman[5], actinomycetes which produce antagonistic substances against other micro-organisms occur naturally more often and in larger numbers in light than in heavy soils, and that the addition of organic matter such as peptone to light soils temporarily reduces the antagonistic activity.

Alexopoulos's attempts[6] to correlate the reported resistance of certain Honduran soils to Panama disease with the occurrence in such soils of micro-organisms producing fungistatic metabolic products can scarcely be regarded as relevant. The same may be said for Meredith's subsequent work[7] in Jamaica on similar lines. For though certain actinomycetes were isolated in both cases, and the cultures of these organisms were shown to inhibit the growth of the Panama disease fungus, *Fusarium oxysporum cubense*, in neither case was any correlation brought to light between the numbers and types of actinomycetes found in resistant soils, and the presence or absence of *Fusarium oxysporum cubense* there. Nor was it indicated why a resistant soil should encourage the growth of the inhibiting strains of actinomycetes, or be a natural habitat for them.

Perhaps these difficulties should not be unduly stressed, for little was known at the time about antibiotics. The actual substance secreted by one of Meredith's actinomycetes was not identified as an antibiotic until 1945[8], and not obtained as a chemically pure substance until 1948[9].

Even though it be of a restricted nature, some information on the likely function of antibiotic-producing micro-organisms in a natural habitat is contained in the observations of Oxford and Singh[10] on the nutritional requirements of myxobacteria. These workers found that, in artificial cultures, certain myxobacteria secrete an antibiotic which inhibits the growth of, and kills, the cells of *Staphylococcus aureus* in preparation for their resolution and digestion by the myxobacteria. Since myxobacteria may now be regarded as true soil inhabitants[11], and since there is little likelihood that the behaviour of these organisms in artificial cultures should be fundamentally different from what it is in their natural habitat, there would here appear to be an isolated case in which a group of soil organisms utilizes the faculty of antibiotic production for its own maintenance, and incidentally also for the suppression of other soil organisms living within the same environment. As such this observation is far more interesting than the recent evidence by Grossbard[12] that fungi and actinomycetes can produce antibiotics in soils mixed with straw or glucose.

When evidence of the part played by antibiotics in soils has become stronger, the most impressive positive contributions will probably have been derived from studies of closer knitted microbial soil

communities than samples of soils collected at random. The very nature of the action of antibiotics supports this claim, for not only is their action space-restricted, but also prevailing physical and chemical conditions may affect them to a marked degree.

Many such close microbial associations can be visualized. The rhizosphere, for example; the areas of decaying vegetable debris in soils into which root systems penetrate with impunity in spite of the active decomposition of cellulose taking place there[13]; the mycorrhiza systems; the mud–water phase of lakes, rivers and seas; sewage[14]; silage and other similar artificial microbial communities of decomposing vegetable debris and many others. Some of these associations are now being explored at the Colonial Microbiological Research Institute and interesting observations are being made, the most noticeable, perhaps, being that the antibiotic-producing microflora, for example, of the rhizosphere, is strongly active against lower fungi, including both plant and animal pathogens. One particular organism, isolated from this habitat, produces an antibiotic, or perhaps several antibiotics, which suppresses not only fungi and yeasts, but also Gram-positive and Gram-negative bacteria with equal facility, while others have a more restricted field of action. There are indications even that some of these antibiotic-producing organisms are specifically adapted to their habitat and depend for their normal development on conditions prevailing there, including, perhaps, secretions from the root system itself. The implications of this, should it be confirmed, might be far-reaching for the control of soil-fungus infections of plants and perhaps bring nearer the day when antibiotics, as visualized by Russell, might take their part in the control of such diseases.

The restricted concept here outlined of the function of antibiotic-producing micro-organisms in natural habitats, important as it may prove to be, does not give an answer to the question whether such organisms are a major factor in the maintenance of a balanced microflora of a soil. From existing knowledge it would be dangerous to deduce that the microflora of any soil could be thus influenced, for even the isolation of micro-organisms with antibiotic properties from a soil does not imply that they are active as regulators of the microflora. Nor could it be assumed that, when none was isolated, soil conditions were unfavourable for the production of antibiotics. The ability to yield antibiotic substances is characteristic of many living cells; and it is dependent not only on available nutrients, but also on some obscure biological heritage, which may suddenly be lost without visible detriment to the cell. This is becoming increasingly apparent in the work now proceeding in Trinidad.

[1] Russell, E. J., *Nature*, **164**, 379 (1949).
[2] Thaysen, A. C., Forsyth, W. G. C., Thaysen, Ingrid, and Maugee, Marcelle, *Nature*, **163**, 835 (1949).
[3] Conn, H. J., *Bact. Rev.*, **12**, 247 (1948).
[4] Nakhimouskaia, N. I., *Microbiol.* (Russian), **6**, 131 (1937).
[5] Waksman, S. A., *Soil Sci.*, **54**, 281 (1942).
[6] Alexopoulos, C. A., *Ohio. J. Sci.*, **38**, 221 (1938).
[7] Meredith, C. H., *Phytopath.*, **33**, 403 (1943).
[8] Thaysen, A. C., and Buthn, K. R., *Nature*, **156**, 781 (1945).
[9] Arnstein, H. R. V., Cook, A. H., and Lacey, M. C., *J. Gen. Microbiol.*, **2**, 111 (1948).
[10] Oxford, A. E., and Singh, B. N., *Nature*, **158**, 745 (1946).
[11] Singh, B. N., *J. Gen. Microbiol.*, **2**, xvii (1948).
[12] Grossbard, E., *J. Gen. Microbiol.*, **2**, xix (1948).
[13] Thaysen, A. C., and Morris, Muriel, Colonial Microbiological Research Institute, Official Opening, 53 (1948).
[14] Sue, T. L., *J. Gen. Microbiol.*, **2**, xxii (1948).

NEWS and VIEWS

Physical Society Awards for 1950: Duddell Medal

THE Council of the Physical Society has awarded the Duddell Medal for 1950 to Mr. D. W. Fry. Mr. Fry was a leader during the War of the Telecommunications Research Establishment group working on problems of basic centimetre-wave techniques. After the War he joined the Atomic Energy Research Establishment and applied his microwave techniques to the development of nuclear particle accelerators. One section of Mr. Fry's group worked on synchrotron development, and converted a small Kerst betatron to synchrotron operation at 18 million volts. This was completed in early 1947, and was the first synchrotron in the world to operate. After that, a 30-MeV. synchrotron was designed for medical work, and one is now operating at the Cancer Research Hospital and another in the Department of Therapeutics in Cambridge. Design work has also been done in collaboration with industry on a 300-MeV. synchrotron for the University of Glasgow. Mr. Fry's group also designed, built and operated a 3·5-million volt travelling-wave linear accelerator. This machine gives a high radiation output and is now being developed for radiotherapeutic work, a 10-MeV. machine being built for the Medical Research Council. Meantime, still higher energy machines are being designed. The work of Mr. Fry's accelerator design group has filled a long-felt want for a small and highly professional team to take the initiative in Great Britain on accelerator development.

Charles Vernon Boys Prize

THE Charles Vernon Boys Prize has been awarded to Dr. G. P. S. Occhialini. Dr. Occhialini is distinguished by his close association with two major developments in the physics of fundamental particles, namely, the counter-controlled cloud chamber and its application to the study of pair production, and the nuclear emulsion technique leading to the identification of π- and μ-mesons. Occhialini joined Blackett at the Cavendish Laboratory in 1932 as a young research physicist already skilled in the use of the Geiger-Müller counter. He applied this experience to the development of the first counter-controlled cloud chamber. In a remarkably short time, photographs establishing the complexity of cosmic shower phenomena were taken and decisive independent evidence of the existence of the position obtained. Thirteen years later, after making several contributions of interest in cosmic-ray physics, Occhialini joined Powell at Bristol to develop the application of nuclear emulsions to cosmic-ray studies. The remarkable achievements of this work are well known and represent the most outstanding discovery in the physics of fundamental particles in the post-war period; it was largely due to Occhialini's enthusiasm and drive that the preliminary technique was so quickly and effectively developed.

It is proposed to hold a meeting of the Physical Society during October, when both Mr. D. W. Fry and Dr. G. P. S. Occhialini will describe some of their researches.

Applied Mathematics at Manchester: Prof. S. Goldstein, F.R.S.

PROF. SIDNEY GOLDSTEIN, who has recently retired from the chair of applied mathematics in the University of Manchester, will shortly be taking up the post of professor of applied mathematics in the College of Technology, Haifa. Between his departure from England and his arrival in Israel, Prof. Goldstein is lecturing in the United States. He expects his duties in Haifa will be arduous for some time to come, and is facing the future in the spirit of a missionary for education and scientific research; he takes with him the goodwill of his considerable circle of friends in Britain. Prof. Goldstein has inspired younger men to follow in his footsteps, and, at Manchester, has established an important school of mathematical aerodynamics. His special interest in aeronautics started at the beginning of the Second World War, when he joined the staff of the Aerodynamics Division of the National Physical Laboratory. While there, he greatly extended the utility of calculations giving a first approximation to the forces on aeroplane wings. At the request of the Aeronautical Research Council, he undertook the editorship of two books on modern developments in fluid mechanics, and these are now in great demand as standard text-books. After being a member of the Aeronautical Research Council for some years, he became its chairman and guided its activities during a period of vigorous expansion. Prof. Goldstein was elected to the Royal Society in 1937, serving on its Council during 1945–47; recently he has been made a foreign member of the Royal Netherlands Academy of Sciences and Letters.

Mr. M. J. Lighthill

MR. LIGHTHILL, who has been appointed to succeed Prof. S. Goldstein, took the mathematics tripos in the University of Cambridge during the Second World War and then worked in the Aerodynamics Division of the National Physical Laboratory on the design of aerofoil sections and on high-speed flow. On returning to Cambridge, he was elected to a fellowship at Trinity College, and, in the following year, he went to the University of Manchester as a senior lecturer in mathematics; prior to his election to the Beyer chair he was due to be appointed as a reader. Mr. Lighthill has written extensively on hydrodynamics and aerodynamics, especially on trans-sonic flow and on shock waves. At the Seventh International Congress of Applied Mechanics, held in London in 1948, he delivered one of the general lectures on "Methods for Predicting Phenomena in the High-Speed Flow of Gases". He has also written on thermo-elasticity and on the application of aerodynamics to astronomy.

Social Science at Birmingham: Prof. Charles Madge

MR. CHARLES MADGE, who has been appointed to the chair of social science in the University of Birmingham as from October next, first made his name by a series of articles in the *Economic Journal* during 1940–41. Encouraged by Lord Keynes, he and a team of field-workers carried out house-to-house visits in Coventry, Blackburn and Bristol, seeking the patterns of expenditure and saving among samples of families of different class. In 1943, he wrote an "Occasional Paper" (of 140 pages) for the National Institute of Economic and Social Research, summarizing his results. He drew here upon further field-work conducted at Glasgow and Leeds, and brought out the mingling of economic and more purely sociological and psychological factors in the "propensity to save". For the same income and family composition a wide variety was found in the proportion of income saved. The high savers in Glasgow, compared to the low savers, were found to be country-born, Presbyterian, right-wing politically, and of smart and mentally bright appearance. After 1942, Mr. Madge devoted himself to the editing of *Pilot Papers*—certainly a pilot among sociological journals—and inquiries into the activities of trade union members, and into the attitudes and the use of leisure of workers interviewed at the bench. For the trade union inquiry Mr. Madge was awarded a Leverhulme research fellowship; some of his conclusions were published in P E P broadsheets and the P E P Report on British Trade Unionism. The work-bench interviews were conducted under the auspices of the University of Birmingham. In 1947 Mr. Madge became social development officer to the Stevenage Development Corporation, from which he resigned in April to become an assistant director of research in the University of Birmingham.

Botany at Stanford University: Prof. William C. Steere

PROF. WILLIAM C. STEERE, head of the Department of Botany in the University of Michigan, has been appointed professor of botany in Stanford University, California, in succession to Prof. Gilbert M. Smith, who retires this year. Prof. Steere will continue a long botanical tradition carried on at Stanford by Prof. Smith and Prof. Douglas Campbell, only living member of the original Stanford faculty. One of the leading botanists in the United States, Prof. Steere's particular field of interest is bryology, and he is editor-in-chief of *The Bryologist*, official journal of the American Bryological Society. He has been a leader of scientific expeditions both in the tropics and the arctic. In 1932 he took part in the University of Michigan-Carnegie expedition to Yucatan. In 1942–43 he was a senior botanist of the Foreign Economic Administration in Colombia and the following year in Ecuador. In 1948 he was a member of an expedition into Northern Canada; and in 1949 he was a member of a U.S. Geological Survey expedition to Alaska. He is forty-two years of age.

United Kingdom Agricultural Representation in the United States and Canada

PROF. R. G. BASKETT, chief scientific officer of the Ministry of Agriculture for Northern Ireland, has been appointed agricultural attaché in Washington, in place of Mr. A. N. Duckham, who will be returning to Great Britain this month. Prof. Baskett, who is a graduate of the Universities of Reading and London, has been associated with agricultural science in Northern Ireland since 1924, when he was appointed research assistant, Chemical Research Division of the Ministry of Agriculture for Northern Ireland, and demonstrator in the Agricultural Chemistry Department of the Queen's University of Belfast. Since 1935 he has been professor of agricultural chemistry

in the Queen's University, and in 1947 he became also chief scientific officer, Ministry of Agriculture for Northern Ireland. He has represented Queen's University on the Inter-University Council for Higher Education in the Colonies and has visited the West Indies on two occasions in connexion with the University College of the West Indies. Prof. Baskett's research work has been mainly concerned with problems in animal nutrition, particularly in the mineral requirements of pigs and poultry, the effects of feeding on the quality of bacon and studies on nutritional anæmia in young pigs.

Mr. W. F. Darke, at present secretary (agriculture) in the office of the United Kingdom High Commissioner in Ottawa, has been appointed agricultural adviser to the High Commissioner and will no longer act as assistant to the agricultural attaché in Washington.

Aircraft De-icing Research

THE Royal Canadian Air Force, Engineering Division, has carried out investigations upon aircraft de-icing for some time past, and now considers that thermal de-icing, or actually anti-icing, appears to hold more promise than either the heated surface, mechanical pulsation, or chemical treatment hitherto employed. It has equipped a large four-engined Rolls-Royce Merlin-powered 'North Star' aircraft with the necessary apparatus for flying tests and observation, and intends to collect meteorological data upon cloud conditions, in a more detailed and precise fashion than has been possible before, as well as to experiment upon the dispersal or prevention of ice accretions.

The principal feature of the 'Ice Wagon' is a large 'shark's fin' on the top of the body. This will be fitted with the electro-thermal de-icing devices, and has blister-type observation domes on either side from which an operator can study and control the ice-shedding process during flight. The propellers are also fitted with similar electric blade-heating, and these are observed either through a stroboscopic viewer, or by stopping the propeller temporarily. The general principle of the new technique is one of intermittent flow of current along wires installed at places where the ice that is forming is most readily dislodged. This is considered to be more efficient than continuous heating of a surface. The considerable electric energy for this, and the various electrical photographic recorders, is supplied by two engine-driven alternators, delivering 60 kW., 208 volts, 3-phase, 400 cycles. The equipment of this machine is based upon tests already carried out in test chambers in a low-temperature laboratory.

Operational Research Quarterly

THE main purpose of the new periodical, *Operational Research Quarterly*, of which the first number was published in March (1, No. 1; pp. 16; London: Operational Research Club, 25 Buckingham Gate, London, S.W.1, 1950; 3*s*. or 10*s*. a year), is to assemble in one place as much as possible of the information that workers in this field require and which at present is scattered over a very wide range of scientific and technical literature. The abstracts are intended primarily to facilitate access to the original sources, and, although in the first issue they are in general historical, the range of journals from which they are taken is sufficiently wide to provide *prima facie* justification for the new periodical. They also illustrate the four main headings under which operational research is grouped: studies of human behaviour by itself, in which group applications in the field of economics are conveniently included; "man and his machines", covering most industrial and military applications; "traffic and flow"; and general papers, including those concerned with the organisation and purposes of operational research itself. It is also proposed to include in each issue an original and provocative article on some aspects of operational research, and the first of these is contributed by Prof. P. M. S. Blackett. In this article he urges that the element of relative novelty of operational research is not so much in the material to which the scientific method is applied as in the level at which the work is done, in the comparative freedom of the investigators to seek out their own problems, and in the direct relation of the work to the possibilities of executive action. The second issue of the journal (June) is on similar lines to the first, the main article being an account by L. H. C. Tippett of the use made of operational research methods in the Shirley Institute, the headquarters of the British Cotton Industry Research Association.

Institution of Electrical Engineers: Premium Awards

THE Institution of Electrical Engineers has made the following awards of premiums for papers read or accepted for publication during the session 1949–50. *Institution Premium:* Dr. J. D. McGee. *Kelvin Premium:* Prof. H. G. Booker and P. C. Clemmow. *John Hopkinson Premium:* D. W. Fry, J. Dain, H. H. H. Watson and H. E. Payne; F. K. Goward, J. D. Lawson, J. J. Wilkins and R. Carruthers. *Non-Section Premiums:* Dr. P. F. Soper (Llewellyn B. Atkinson Premium); H. R. Broadbent; C. M. Cock; L. H. A. Carr. *Measurements Section Premiums:* W. S. Melville (Silvanus Thompson Premium); R. O. Carter and D. L. Richards (Mather Premium); S. F. Musson and R. E. Mell; A. R. Boothroyd, E. C. Cherry and R. Makar; Prof. F. C. Williams and S. W. Noble; K. H. Stewart; N. F. Astbury, Dr. T. Emmerson and J. McFarlane. *Radio Section Premiums:* Dr. F. E. Jones and E. C. Cornford (Duddell Premium); Dr. L. G. H. Huxley and J. A. Ratcliffe (Ambrose Fleming Premium); Dr. E. L. C. White and M. G. Harker; Dr. J. L. Pawsey; B. Y. Mills; W. T. Duerdoth; J. E. N. Hooper and A. A. Kippax; S. de Walden and J. C. Swallow; G. Millington and G. A. Isted. *Supply Section Premiums:* A. T. Chadwick, J. M. Ferguson, D. H. Ryder and G. F. Stearn (Sebastian de Ferranti Premium); Dr. J. S. Forrest (John Snell Premium); G. Lyon. *Utilization Section Premiums:* F. W. Cox and W. E. Swale (Crompton Premium); R. T. Coe and D. F. Welch (Swan Premium); A. R. H. Thorne. *Fahie Premium:* T. H. Flowers and D. A. Weir. *Heaviside Premium:* H. J. Josephs. *Paris Exhibition (1881) Premium:* L. Gosland. *Overseas Premiums* (for senior members): A. J. G. Gosling; (for students and graduates): J. W. Crompton.

International Optical Commission

MEETINGS of the International Optical Commission will be held in London in the apartments of the Royal Society during July 17–18. The Commission, which is part of the International Union of Pure and Applied Physics, was constituted at Delft in 1948 after a preparatory meeting in Prague in 1947, and its purpose is to further international scientific

relations in the field of optics. The London meeting is the first since the formation of the Commission in Delft, and there will be some thirty representatives from Belgium, Spain, the United States, France, Great Britain, Italy, the Netherlands, Poland, Sweden, Switzerland and Czechoslovakia. The president of the Commission is Mr. T. Smith (Great Britain), and the secretary is Prof. P. Fleury, of the Institut d'Optique, Paris. The Commission will be followed by, and will hold joint meetings with, the London Conference on Optical Instruments which is being held at the Imperial College of Science and Technology in South Kensington during July 19–26.

University News :

Edinburgh

THE honorary degree of LL.D. of the University of Edinburgh has been conferred on the following, among others : Prof. E. N. da C. Andrade, director in the Royal Institution ; Prof. H. J. Fleure, emeritus professor of geography in the University of Manchester ; and Sir Edward Salisbury, director of the Royal Botanic Gardens.

Birmingham

AT the recent annual degree congregation of the University of Birmingham, the Chancellor (Mr. Anthony Eden) conferred degrees on more than seven hundred students, including thirty-two who received the degree of Ph.D. The honorary degree of D.Sc. was conferred on Mr. Leonard Colebrook, formerly chief officer of the Burns Unit of Birmingham Accident Hospital ; Prof. H. McLean Evans, of the University of California ; and Prof. M. L. E. Oliphant, until recently director of the Physics Department of the University (see *Nature*, July 8, p. 54).

Aberdeen

AT the recent graduation ceremonies at the University of Aberdeen, the honorary degree of LL.D. was conferred on the following, among others : Sir Frederick Bain, deputy chairman of Imperial Chemical Industries, Ltd. ; Dr. H. R. Dean, professor of pathology, University of Cambridge ; and Prof. Yves Milon, professor of geology and dean of the Faculty of Science in the University of Rennes. The degree of D.Sc. was conferred on Dr. A. Milne, for a thesis on "The Ecology of the Sheep Tick, *Ixodes ricinus* L." ; and on Dr. W. F. Watson, for a thesis on "The Optical and Photochemical Properties of Chlorophyll".

Durham

THE following appointments in the University of Durham have been announced : Dr. K. C. Dunham, of the Geological Survey of Great Britain, to be professor of geology ; Dr. D. H. Valentine, reader in botany in the University, to be professor of botany ; and Mr. J. B. Cragg, reader in zoology in the University, to be professor of zoology.

Leeds

THE following appointments to lectureships in the University of Leeds have recently been announced : Dr. A. T. Austin (organic chemistry), Dr. R. Harper (industrial psychology), O. von Knorring (mineralogy and geochemistry), T. K. Marshall (forensic medicine), Dr. Marie F. E. Nicolai (botany), and W. J. O'Connor (senior lecturer in physiology).

London

THE following appointments in the University of London have been announced : Mr. Richard M. Titmuss to the University chair of social administration tenable at the London School of Economics and Political Science ; Mr. J. Hadji-Argyris, to the University readership in the theory of aeronautical structures tenable at the Imperial College of Science and Technology ; Dr. Henry McIlwain, to the University readership in biochemistry tenable at the Institute of Psychiatry.

Sheffield

THE following appointments have been made in the University of Sheffield : Dr. W. Whitaker, lecturer in medicine ; P. Freeman, at present research assistant to the professor of engineering, to be lecturer in engineering ; and S. I. Evans, lecturer in the Department of Fuel Technology.

Announcements

THE annual meeting of the French Association for the Advancement of Science will be held at Toulouse during September 11–16.

DR. T. EMMERSON has been appointed director of research for the G.K.N. (Guest, Keen and Nettlefolds) group of companies. Dr. Emmerson joined Messrs. Joseph Sankey and Sons, Ltd., in 1945, after spending the war years in research for the Admiralty, and has been acting director of the G.K.N. Laboratories since last autumn, when Mr. N. F. Astbury resigned to take up a research appointment in Australia.

THE Faraday Society is organising a general discussion on "Spectroscopy and Molecular Structure" and "Optical Methods of Investigating Cell Structure", to be held in the Department of Zoology, University of Cambridge, during September 25–28. The programme for the former subject will be divided into three parts—spectroscopy and molecular structure, vibrational and rotational spectra of simple molecules, and vibrational spectra of complex molecules ; for the latter discussion there will be two topics—microscopical apparatus (instrument design and technique) and application of micro- and macro-spectrography. Forms of application for accommodation can be obtained from the Secretary of the Faraday Society, 6 Gray's Inn Square, London, W.C.1.

THE Department of Education of the International Wool Secretariat is arranging a residential summer school to be held at the Scottish Woollen Technical College, Galashiels, during August 7–11. The course is designed primarily for teachers and instructors in all types of school and technical institute, and the subjects to be considered will include the relation of wool to history, geography, economics, commerce, arts and crafts, and natural and domestic sciences. Particulars can be obtained from the Director of Education, International Wool Secretariat, Dorland House, Regent Street, London, S.W.1.

THE "Report on the Chemical Industry, 1949", prepared by the Association of British Chemical Manufacturers at the request of the President of the Board of Trade, contains a chart which sets out the principal products of the chemical industry in Great Britain and shows broadly how the starting raw materials are further treated and made into final products for most other industries. This chart has been published separately and can be obtained (price 1*s.*, post free) from the Association of British Chemical Manufacturers, 166 Piccadilly, London, W.1.

EFFECTS OF RADIO GYROINTERACTION AND THEIR INTERPRETATION

By MARIO CUTOLO

Centro Studi di Radiopropagazione e Radionavigazione, Istituto Fisica Tecnica, University of Naples

TWO articles have been published, in *Nature* and elsewhere[1], describing experiments on gyro-interaction made in Italy in June 1948. It was affirmed in them that the frequency of the disturbing station, 1,127·8 kc./s., was equal to the local gyro-frequency at Montefalco, the mid-point between Taranto (wanted station) and Turin (receiving station).

More recent experiments on gyrointeraction have made use of a disturbing station the frequency of which varied about the gyrofrequency. We have thereby been able to explain the experiments of 1946 and 1948, to correct the results then obtained and to show that the frequency of 1,127·8 kc./s. would not be the local gyrofrequency but about 62 kc./s. below it.

Our first experiments in 1946 to determine the frequency on which the maximum gyrointeraction took place made use of a wanted frequency of 475 kc./s. Since we thought that interaction at that frequency would occur at a height greater than 100 km., where the gyrofrequency would be about 1,162·7 kc./s., we varied the frequency of the unwanted station from 1,200 kc./s. to 1,111 kc./s. (250 metres to 270 metres). The experiments showed that the (gyrointeraction) phenomenon appears often with a disturbing wave of frequency 1,127·8 kc./s.[2]. We took this to be the gyrofrequency in our later experiments in 1948.

Having seen in 1946 that the phenomenon was obtained with disturbing waves the frequency of which was varied smoothly with time during the night, we considered whether the explanation might be due to a variation of gyrofrequency instead of the existence of a double-peaked curve (see Fig. 1). We had obtained the phenomenon between 0100 and 0200 hr. mainly on a frequency of 1,127·8 kc./s. and between 0200 and 0300 hr. on 1,162·8 kc./s. If these two frequencies had been those corresponding to the maxima of the double-peaked curve, then the phenomenon should have been observed every time the frequency of the disturbing station was changing in the band 1,111 kc./s. to 1,200 kc./s. (which occurred many times in an hour), and the maxima of interaction would have appeared at short time intervals instead of an hour or more apart as was, in fact, the case.

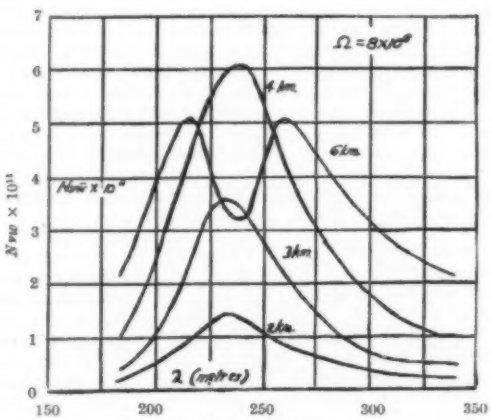


Fig. 1

Afterwards, M. Carlevaro[3] explained the observed facts on the basis of V. A. Bailey's theory and showed that the resonance frequency and not the gyro-frequency was varying.

Recent experiments (June–July 1949), which we regard as crucial, have enabled us to explain several earlier measurements. Taranto (475 kc./s., 1 kW.) operated as the wanted station with Turin as receiving station with the same technique as that used earlier[4]. Radio Florence II was substituted for Radio Vatican as disturbing station and worked with 3·3 kW. power and 80 per cent modulation at 230 c./s. The carrier frequency varied from 1,092 kc./s. to 1,333·33 kc./s., so as to pass through the gyrofrequency, which was estimated to be 1,190 kc./s. at 90 km. height above the earth. Experiments were carried out on twelve nights between 0100 and 0330 Central European Time.

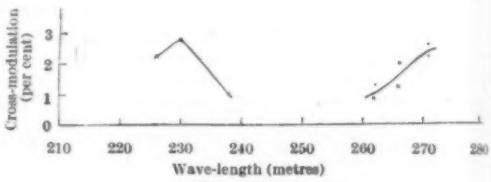


Fig. 2. July 2

We found that, with a wanted frequency of 475 kc./s., we obtained the double-peaked curve as found theoretically by V. A. Bailey (Fig. 1). These curves, which are based on Bailey's theory, show how the degree of interaction varies with depth of penetration into the *E*-layer as the frequency of the disturbing station is varied around the gyrofrequency. The lower surface of the *E*-layer is taken at a height of 90 km. above the earth[5].

In Fig. 1 the abscissæ are the wave-lengths of the disturbing station and the ordinates are the interaction indices, $N\nu\overline{w} \times 10^{11}$, where N is the number of electrons per cm.^{3}, ν the collisional frequency and $\overline{w}$ the mean work done by the wave on the electron between two collisions. It can be shown that

$$\int_0^s N\nu\overline{w}\,ds$$

is proportional to M, the percentage cross-modulation, where s is the path-length in the ionosphere of the wanted wave.

The observed variation of cross-modulation with frequency is plotted in the graphs of Figs. 2 and 3,

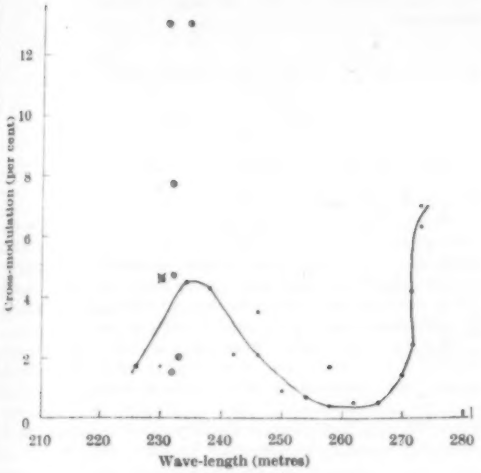


Fig. 3. July 9

where the abscissæ are the wave-lengths of the disturbing station and the ordinates are the values of M. Where necessary, the values obtained on a given frequency in the same frequency sweep have been averaged. The points marked with a circle in Fig. 3 relate to measurements made at a different time from that to which the main curve relates. Fig. 2, obtained during the night of July 2, shows the lower maximum of the double-peaked curve; only the rising branch of the graph was obtained on longer wave-lengths, owing to the inability of the Florence II station to work on that night on a frequency less than 1,111 kc./s. Fig. 3 clearly shows one of the maxima at 1,276·5 kc./s. (236 m.) and the rise and fall of interaction near it. In these experiments it was not possible to obtain the other maximum owing to the limitation of frequency variation of the Florence II station to between 1,090·9 kc./s. and 1,327·43 kc./s.

A clearer definition of the second maximum was obtained on the night of July 13 (Fig. 4), when it was found that the interaction was a maximum for a disturbing station frequency of 1,090 9 kc./s. (274 m.).

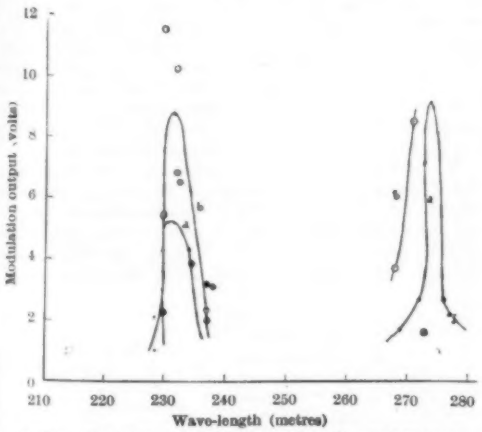


Fig. 4. July 13: (*a*) 01.22–02.28 hr.; (*b*) 02.37–03.30 hr.

In these curves the ordinates show the actual output voltage of the received cross-modulation.

As will be seen from the experimental curves, the point of minimum interaction index, corresponding to the frequency of the disturbing station equal to the local gyrofrequency, *has only been obtained once* and with *a cross-modulation depth of 0·5 per cent.* As the apparatus enabled modulation depths of the order of 0·25 per cent to be measured, it may be concluded that the interaction on other occasions was less than this amount.

The gyrofrequency deduced from the mean frequencies of the two maxima in Fig. 4 (curve *a*) is 1,190 kc./s., while the theoretical value is 1,200 kc./s.

The minimum interaction as shown in Figs. 2, 3 and 4 is obtained on a frequency corresponding to the local gyrofrequency at the mid-point between Taranto and Turin, that is, above Montefalco, where, presumably, the reflexion point of the wanted wave lies.

Fig. 5. *To*, Turin; *M*, Milan; *Fl*, Florence; *Fo*, Foligno; *Mo*, Montefalco; *L*, Larino; *R*, Rome; *N*, Naples; *Ta*, Taranto

During the 1948 experiments, Radio Vatican was used as the disturbing station. In this case it was expected that the interaction would take place above Larino (Campobasso), south of Rome, as suggested by Huxley's observations[6]. On the other hand, the waves from Taranto would follow two paths, the interaction with Rome taking place over Larino (first reflexion point of the double hop path), while that produced by Florence II would take place over Montefalco (reflexion point of the single hop path). Since the gyrofrequencies at Larino and Montefalco are little different, it may be that, if we had used Rome instead of Florence during the last cycle of experiments, we would have obtained a curve very like those of Figs. 2, 3 and 4.

From these considerations we conclude that the frequency of 1,127·8 kc./s. used in 1948 by Rome was *not the gyrofrequency*, but that it lay very near the upper maximum and thus was far enough removed from the gyrofrequency. In this manner we explain the large percentage of cross-modulation obtained on a frequency of 1,127·8 kc./s. relative to that obtained at a frequency equal to the local gyrofrequency. Having found the maxima in the curve relating

percentage cross-modulation and frequency, we have obtained the average frequency corresponding to them. This gives for the experimental gyrofrequency a value of 1,190 kc./s., which is in close agreement with the theoretical value of 1,200 kc./s. From the formula $\Omega = eH/2\pi m$, we obtain $H = 0{\cdot}4245$ oersted. This is lower than the values for the earth's surface ($H = 0{\cdot}4477$ oersted) and that calculated from Smith's formula.

It may be stated that the experiments on gyro-interaction made up to now have shown that, to obtain a large cross-modulation with a power of 3–5 kW. at the disturbing station, we require less power at the wanted station (1 kW.), and we also require the disturbing station frequency to be varied about the maxima and not to emit on the gyro-frequency only. We must also ensure that the locations of the transmitting and receiving stations are suitable.

Solar activity exerts a great influence on gyro-interaction. We have always observed that the effect is weak or absent for a Wolf's number up to 100. Indeed, on the twelve nights of the experiments, we observed the phenomenon only six times, and on only two of these occasions was the effect clearly seen.

This work has been conducted with the assistance of Dr. R. Ferrero, Dr. M. Motzo, Mrs. V. Martini and P. Mirabella.

[1] Cutolo, M., and Ferrero, R., *Nature*, **163**, 58 (1949); *Alta Frequenza*, **17**, 212 (1948); *Nuovo Cimento*, **5** (October 1948).
[2] Cutolo, M., Carlevaro, M., and Ghersini, M., *Alta Frequenza*, **15**, 111 (1946).
[3] Carlevaro, M., *Nuovo Cimento*, Milan, **5**, 6 (1948).
[4] *Alta Frequenza*, **18**, 212 (1948).
[5] Bailey, V. A., *Phil. Mag.*, **23**, 929 (1937); **26**, 425 (1938).
[6] Huxley, L. G. H., Foster, H. G., and Newton, C. C., *Proc. Phys. Soc.*, **61**, 134 (1948).

A MICROSCOPIC ELECTROPHORESIS CELL

By Prof. A. J. RUTGERS and L. FACQ
University of Ghent
AND
Dr. J. L. VAN DER MINNE
Koninkijke/Shell Laboratory, Delft

ONE of the important difficulties in the microscopic measurement of the electrophoretic speed of particles in a colloid or in a suspension is the simultaneous movement of the liquid due to electrosmosis along the walls of the cell. This electrosmosis may set up a difference in hydrostatic pressure, giving rise to flow of the liquid. The velocity of the liquid flow v must therefore be subtracted from the observed velocity of the particle in order to obtain the electrophoretic velocity (Quincke, 1861).

$$v_{\text{E.Ph.}} = v_{\text{obs.}} - v.$$

Assuming the liquid to be purely viscous (Poiseuille) and the cell to be cylindrical (with radius r_0), the velocity at various distances r from the axis, v_r, is:

$$v_r = v_{\text{E.O.}} - v_{\text{Pois.}} = v_{\text{E.O.}} - \frac{p}{4\eta l}(r_0^2 - r^2).$$

If we work with a closed cylindrical capillary in which total flow is zero, then:

$$v_{\text{E.O.}}\,\pi r_0^2 = \frac{p}{8\eta l}\pi r_0^4,$$

and the velocity at the distance r from the axis is therefore:

$$v_r = v_{\text{E.O.}} - \frac{p r_0^2}{4\eta l}\left\{1 - \frac{r^2}{r_0^2}\right\} = v_{\text{E.O.}}\left[1 - 2\left\{1 - \frac{r^2}{r_0^2}\right\}\right] = v_{\text{E.O.}}\left(\frac{2r^2}{r_0^2} - 1\right).$$

We see that v_r vanishes at $r = \frac{r_0}{\sqrt{2}} \simeq 0{\cdot}71\, r_0$. This is von Smoluchowski's derivation (1914).

Measurement at this distance ($0{\cdot}71\, r_0$) from the axis gives the electrophoretic speed of the particle directly. The drawback to this procedure, however, is that dv/dr is large at $r = 0{\cdot}71\, r_0$, so that a small error with respect to the depth at which measurement is performed causes a considerable error in $v_{\text{E.Ph.}}$

Due to the fact that necessarily microscopic objectives of the small magnifying type have to be used (large working distance), involving a great depth of focus, and that all deviations from pure symmetry, such as an imperfect capillary, and sedimentation seriously impair the accuracy because determinations are not effected in the plane of symmetry, the above procedure is usually found unsatisfactory.

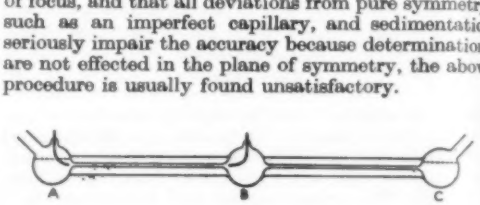


Fig. 1

For many years past, experimenters have therefore been seeking for cells in which the liquid is stagnant in the axis. The first attempt we know of is that of Van der Grinten[1], who closed the cell at both ends by making use of the surface tension between liquid and air. By this means he obtained a reduced counterflow in the cell, and in certain cases he showed that this cell gave no movement of the liquid in the middle plane (his cell being of rectangular cross-section). However, this was found not to be true for every case[2], as might have been expected.

A second attempt to construct such a cell was made by Smith and Lisse[3]. They connect two reservoirs by two capillaries with a ratio of radii to lengths such that when the electric field, acting on both capillaries, is applied, the speed in the axis of the narrower capillary is reduced to zero, while the speed in the axis of the wider capillary is somewhat increased. This method, however, only gives good results if the ζ-values at the glass–water interfaces of both capillaries are the same, which will not in general be the case; besides, the apparatus of Smith and Lisse is not of very simple construction.

We have attempted to construct an apparatus which combines the advantages of the two methods mentioned, and avoids their disadvantages. In one cell the pressure necessary to bring movement in the axis to zero is created by making the liquid flow through an extension of the same capillary.

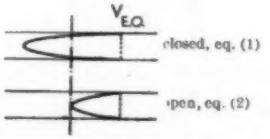


Fig. 2

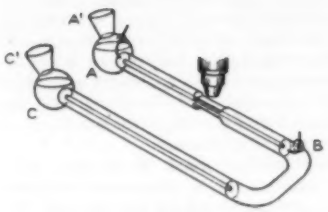


Fig. 3

Consider the flow of the liquid in the system shown in Fig. 1; the two capillaries have the same radius and length; the spherical vessels A and C are so large that no appreciable difference of height between the levels of the liquid in A and C arises during an observation.

If an electric field E is applied between the electrodes in the vessels A and B, the liquid will move from A to B; the hydrostatic pressure in B will become $1 + p$; this pressure will cause a Poiseuille flow of liquid from B to A and from B to C; the total flow of liquid from A to B must be equal to that from B to C:

$$v_{\text{E.O.}}\,\pi r_0^2 - \frac{p}{8\eta l}\,\pi r_0^4 = \frac{p}{8\eta l}\,\pi r_0^4.$$

Hence:

$$\frac{p r_0^2}{4\eta l} = v_{\text{E.O.}}.$$

For v_r we have:

$$v_r = v_{\text{E.O.}} - \frac{p r_0^2}{4\eta l}\left\{1 - \frac{r^2}{r_0^2}\right\} = v_{\text{E.O.}}\left[1 - \left\{1 - \frac{r^2}{r_0^2}\right\}\right] = v_{\text{E.O.}}\,\frac{r^2}{r_0^2}. \qquad (2)$$

We see that, just as in the case of equation (1), we again obtain a parabolic velocity distribution; but now the speed of the liquid vanishes in the axis of the capillary. This result is valid, irrespective of the ζ-value of the glass–water interface in the capillary

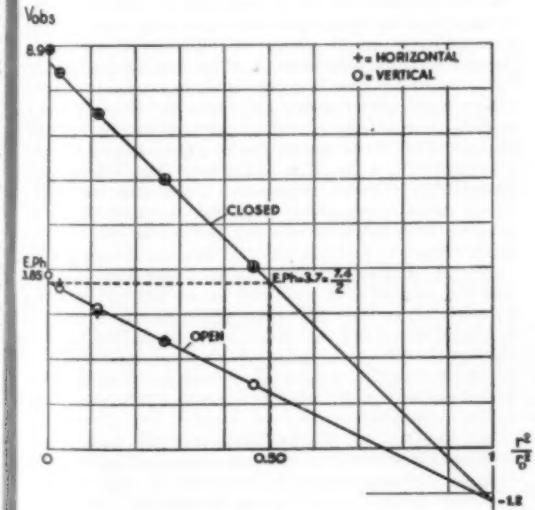


Fig. 4

BC. The same principle may be applied to cells of other than circular cross-section.

The velocity distributions according to equations (1) and (2) are given in Fig. 2. The condition of equal radii can easily be satisfied by constructing the whole apparatus from one capillary AC, in which a spherical vessel is blown at B; even so, the radii will not be exactly equal; but the equality of Poiseuille flow from B to A and from B to C can be preserved by adjusting the lengths of AB and BC in the following way:

$$r_2 = r_1\,(1 + \rho)\,;\; l_2 = l_1\,(1 + \lambda)\,;\; \lambda = 4\rho.$$

For actual measurements, the apparatus has been given the shape shown in Fig. 3; it can be used in a horizontal as well as in a vertical position.

In order to obtain a sharp image, flat surfaces have been ground in the tube above and below the capillary. In that case, the distance r from the axis at which a measurement is performed is found in the following way.

Let the displacement of the microscope required in order to shift the focus from the roof of the capillary to the point to be measured, be m; then r follows from an elementary computation:

$$\frac{r}{r_0} = \frac{r_0 - n_{\text{gl.}}\,m}{r_0 - (n_{\text{gl.}} - n_{\text{w.}})\,m}, \qquad (3)$$

where $n_{\text{gl.}}$ and $n_{\text{w.}}$ are the refractive indices of glass (1·48) and of water (1·33).

In order to verify the electrophoretic speeds obtained, the apparatus may be used in the *open* condition (as described previously) or in the *closed* condition; for the latter, the vessels A and C are filled with liquid, and closed with stopcocks fitting at A' and C', or with very narrow capillaries through which the excess of liquid can escape; if now an electric field is applied between A and B, the total flow of liquid in the system is zero, and equation (1) applies.

Table 1. Values of $v_{\text{obs.}}$ in μ/sec./volt/cm.

$\frac{r}{r_0}$	$\frac{r^2}{r_0^2}$	Open		Closed	
		hor.	vert.	hor.	vert.
0·6826	0·4659	—	1·40	4·0	4·0
0·5152	0·2654	2·34	2·40	6·0	6·0
0·3415	0·1166	2·96	3·16	7·4	7·4
0·1611	0·0259	3·69	3·56	8·4	8·4
0	0	3·85	3·86	8·9	8·9

Capillary $r_0 = 0{\cdot}22$ mm.
$l = 5{\cdot}3$ cm.

Table 2. Values of $v_{\text{E.O.}}$ and $v_{\text{E.Ph.}}$

	Open		Closed	
	hor.	vert.	hor.	vert.
$v_{\text{E.O.}}$	4·8	4·8	4·9	4·9
$v_{\text{E.Ph.}}$	3·7	3·7	3·7	3·7

Measurements with emulsions of tetraline (+ 1 per cent of palmitic acid) in water were carried out to test the apparatus, which was used in the horizontal and in the vertical position, both opened and closed. Some of the results are given in Tables 1 and 2, and in Fig. 4; in this figure the speeds found for the particles ($v_{\text{obs.}}$) are plotted on the y-axis; the distances from the axis r are plotted as r^2/r_0^2 on the x-axis, in order to obtain straight lines. The slope of the curve for the closed system equals 2 $v_{\text{E.O.}}$, for the opened one it is $v_{\text{E.O.}}$; the electrophoretic speed of the particles is directly found at $r^2/r_0^2 = 0{\cdot}50$ for

the closed system, and at $r = 0$ for the open system; we see that the values obtained are in agreement.

Note added in proof. Dr. Hl. de Vries, Groningen, suggests an improvement of the optical arrangement. Our formula (3) applies only to a plane perpendicular to the capillary axis; in a vertical plane through the axis, the correction reads simply

$$r = r_0 - n_w m.$$

Our method will therefore suffer from a certain astigmatism, causing an inaccuracy in the determination of the height of the particles in the lower parts of the capillary. The obvious remedy is the use of a slit (perpendicular or parallel to the capillary axis) as a source of light.

[1] *J. Chim. phys.*, **23**, 209, 226 (1926).
[2] de Kadt, *Koll. Chem.*, Beiheft, **32**, 294 (1931).
[3] *J. Phys. Chem.*, **40**, 399 (1936).

QUANTITATIVE INHERITANCE

A COLLOQUIUM on quantitative inheritance was held under the auspices of the Agricultural Research Council in the Institute of Animal Genetics, Edinburgh, during April 4–6. The meeting was designed to elicit critical discussion of the approach to problems of multifactorial inheritance, and the variety of papers and vigorous discussion amply fulfilled its purpose.

Prof. Sewall Wright opened the meeting with a wide-ranging historical account of the growth of the concepts used in the study of quantitative inheritance, and outlined the various levels—from primary gene action to organised patterns—at which experimental work could be carried out. He emphasized the vast gap between speculation and certainty in these complex genetic situations. The familiar assumption of additive gene action may be less applicable than is currently supposed. He presented statistical methods of estimating numbers of effective factors from crosses between extreme strains on various assumptions about the magnitude of their individual effect. In a second paper he illustrated many of these concepts from his extensive data derived from guinea pigs. In particular, he stressed the need for suitable scale transformation where possible, although many cases of untransformable interaction have arisen in his work—particularly with coat colour.

Considering the subject from the embryological point of view, Prof. C. H. Waddington emphasized the self-regulating properties of the organism and the need for linking the purely genetic concepts of gene segregation with the functional activity of genes in producing a highly differentiated animal or plant. It is helpful to consider the gene-controlled processes as canalized in development; barriers to organic change can be thought of in terms of sharpness of the canalization, and it might be possible to alter this experimentally by introducing striking mutants or altering the environment. Provided the developmental process concerned is thereby influenced, selection might be made more effective.

Dr. Cecil Gordon presented an analysis of a series of mutant lines inbred by Timoféeff-Ressovsky. The lines differ characteristically in the variability of exhibition of the mutants and raise the question of how to treat this variability in crosses. It may be necessary to develop new statistical methods to cope with differing sensitivity of genotypes to the same range of environmental conditions, in place of the current manner of estimating the portion of the observed variance due to environmental conditions. In a second paper, he described the types of allele, extremely sensitive to both genetic and environmental conditions, revealed by inbreeding wild populations, and suggested that the importance of such 'bad' genes has been grossly underrated.

The next speaker, Prof. K. Mather, described the detailed analysis of a replicated experiment with *Nicotiana rustica*, designed to analyse the observed variance in height and flowering time, from F_2, F_1 and backcross data derived from a wide cross. He presented data for two consecutive seasons with widely differing weather conditions and showed there was a considerable genotype-environment interaction—a factor of importance in practical plant-breeding work.

Prof. J. B. S. Haldane described types of genetic variation likely to be found in natural populations. These can be considered under such headings as: genes that are more or less neutral with respect to selection; transient genes, that is, alleles on their way to fixation or elimination; clinal genes, originating via migration from centres differing in gene frequency; mutation; selection of heterozygotes, due to their greater fitness; opposite effects of genes on the two sexes; cases where the selective value of a genotype depends on the genetic constitution of the rest of the population, as in some of the blood groups; and, finally, equilibrium due to differences in direction of selection in zygote and gamete. He quoted various examples and emphasized the need for experimental work designed to assess the relative importance of these possibilities.

Data relating to human characters were presented by Prof. L. Penrose, which suggest that there is a tendency for the variability of parents to be less than that of their progeny. It is conceivable that parents tend to come from the central region of the total distribution. He suggested several genetic models which might account for stability of such a phenomenon.

Dr. B. Woolf thought that under-estimation of the importance of the environment largely accounts for the discrepancy between response to selection and observed heritability in animal breeding. He quoted examples, in illustration, and warned against the danger of misinterpretation of statistical analysis.

In referring to his work with the inheritance of seed weight in the castor-oil plant, Dr. S. C. Harland said that variation in such characters can be roughly assigned to three categories: cases where clearly identifiable genes with relatively big effects are responsible; those where modifiers are relatively much more important; and, finally, those where it is quite impossible to identify particular genes. The work referred to comes into the last-mentioned group.

Mr. A. Robertson derived an expression for the rate of genetic improvement in an animal-breeding programme in terms of the possible selection and the heritability of the character concerned. He applied this method to the results of selection actually practised by dairy cattle breeders and showed that the probable rate of genetic improvement is of the order of three gallons a year.

An analysis of the variation in milk yield, both within and between herds, was presented by Dr. J. M. Rendel. From a sample drawn from the highest-yielding herds available, he concluded that only thirty per cent of the variation within herds is genetic

in origin. The variation between herds is more difficult to assess, but, from cases where the same bulls have been used in herds at greatly different levels of yield, it seems likely that the greater part of the differences have been due to management.

In reports by Dr. E. C. R. Reeve and Dr. F. W. Robertson on different aspects of their work on the inheritance of body size in *Drosophila*, the former dealt with the study of a strain selected for large size, and the latter with the estimation of differences between chromosomes from different selected strains. One strain which had long failed to respond to selection, in spite of retaining a very high heritability, has been subjected to a detailed biometrical analysis. Different genetic models were discussed to explain the results of selection on size and on the genetic correlation between wing and thorax length. Apparent lethals in the third chromosome were very sensitive to genetic background. A chromosome assay technique was used for comparing the effects on size of individual chromosomes from a number of selected lines against different genetic backgrounds. Use of such independent estimates to forecast the size of various genotypes revealed some striking non-additive interactions between chromosomes, particularly when more than one chromosome set was heterozygous.

Dr. Cavalli gave a description of experiments designed to estimate components of variation attributable to linkage in crosses between strains of *Drosophila* selected for high and low bristle number. These demonstrated the comparative inefficiency of second-degree statistics based on F_2 and F_3 data. He presented a theoretical treatment of the contribution of linkage of varying degree.

The effects of selecting mice on an unrestricted and a restricted diet for large size at six weeks were then described by Dr. D. Falconer. Size increased in both lines. When both lines were tested on the same diet, the low-plane mice grew almost as big as the high-plane mice on the good diet, and bigger than high-plane mice on the poor diet. It was suggested that different physiological characters had been selected in the two lines.

In summing up, Prof. Haldane expressed the thanks of the guests for such a stimulating meeting. He commented that a number of workers in the Institute of Animal Genetics are engaged on both fundamental studies and practical animal-breeding research—an excellent way of linking theory and practice. He directed attention to the urgent need for more detailed experimental work and touched on the gap between biochemical research in genetics and studies of quantitative inheritance. He concluded that new statistical methods may have to be fashioned as experimental work grows.

SCIENTIFIC DEVELOPMENT AND INDUSTRY

A SERIES of articles by the scientific correspondent of the *Financial Times*, published in June 1948, entitled "The Neglect of Science", are worth recalling in connexion with the current debate on technological education. The first of these, dealing with science and industry, reviews the causes of the technological backwardness of much of British industry, due to the belief of industry that there was no urgent need of new developments, and the consequent exclusion of the scientific workers from executive or administrative responsibility and the neglect of research. The functions of an industrial research laboratory are discussed in the second article, where the importance of scientific representation at the highest level is stressed. The shortage of scientific workers makes it difficult to expand research; and it is stated that a contributing factor is the loss to other countries such as the United States of first-class technologists to take up, for example, high industrial positions. On the whole, the kind of education offered to potential scientific workers by the universities is regarded as satisfactory. The real shortcomings are in the field of technical education, and, discussing this question, the third article urges the building of at least two institutions like the institutes of technology at Zurich and Massachusetts, of full university status and demanding high standards. This is suggested as a very worthy object for Marshall Aid; but it is recognized that in some subjects it would be necessary to obtain teachers from abroad. The view is taken that attempts to patch the present system of technological education in Britain would be fatal.

In a subsequent series of articles entitled "A Scientist Looks at America", published in the *Financial Times* last January, reference is made to the concern of scientific men in the United States about the secrecy regulations imposed in connexion with atomic energy work, and about the high proportion of the money spent on research which is drawn from military sources. The article quotes from a statement issued by the American Chemical Society urging a revised approach not only towards secrecy but also towards other questions of policy, and maintains that the false notion that secrecy means security may lead to possible destruction. Scientific opinion is against the view that government funds for science in general should be distributed by the military, even if at present the distribution is very fair. A second article, dealing with the relations between science and industry, comments on the growing strength of American industry and the advantage the United States has reaped, particularly in theoretical physics, from the absorption of large numbers of the scientific men and engineers expelled from Central Europe, and especially Germany, since 1933. The main weakness in the scientific side of American life is in fundamental science, and it is suggested that conditions of life in the United States may conduce in future, as in the past, to American dependence on European workers for fundamental ideas; it is thus a serious matter for Europe as well as for the United States that European scientific workers seem increasingly to desire to settle in America. Americans themselves, like Dr. K. T. Compton, are anxious to see European science restored to its pre-war vigour; but apart from the much smaller economic units in Europe there are other factors to be considered. In spite of brilliant individualists, the French, for example, have fallen back in most technical fields where a scientific background and team-work are essential; and reviewing the significant lessons for Britain in the light of American experience, the concluding article reiterates the plea put forward in 1948 that the most important step required to make British industry competitive is reform of technological education. For this the full support of industry is essential. An improvement in the position of scientific workers is also required if full efficiency is to be achieved and migration to America checked.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Nomenclature of the Steroidal Sapogenins

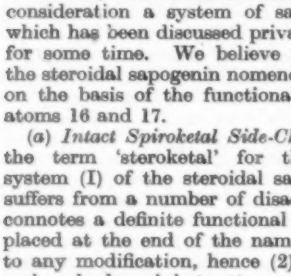
In a recent communication, Klyne[1] made the very timely suggestion that the present trivial nomenclature of cardiac aglucones, toad poisons and steroidal sapogenins be put on a more rational basis. It seems desirable to discuss thoroughly the various proposals which, prompted by Klyne's paper, it is hoped will now be forthcoming, before adopting a definite system. We feel that the fundamental assumption of Klyne's proposals—the introduction of a few new basic terms with elimination of the tremendous number of trivial ones—is eminently sound. However, his suggestions in regard to steroidal sapogenin nomenclature appear to us to suffer from a number of defects, and we should like to submit for general consideration a system of sapogenin nomenclature which has been discussed privately in this laboratory for some time. We believe it necessary to divide the steroidal sapogenin nomenclature into three parts on the basis of the functional side-chain at carbon atoms 16 and 17.

(*a*) *Intact Spiroketal Side-Chain.* Klyne[1] suggests the term 'steroketal' for the fundamental ring system (I) of the steroidal sapogenins. This name suffers from a number of disadvantages: (1) 'ketal' connotes a definite functional moiety and, by being placed at the end of the name, does not lend itself to any modification, hence (2) all functional groups such as hydroxyl, keto, etc., and degrees of unsaturation have to be placed in the beginning, as in 2,3-dihydroxy-12-keto-Δ^5-22-*iso*steroketal for kammogenin (IV); (3) the ending 'al', usually indicative of an aldehyde group, differs (phonetically and logically) from the ending 'ane' universally employed in steroid nomenclature (pregnane, cholestane, etc.). We believe that the term 'spirostan' overcomes all the above-mentioned difficulties, the prefix 'spiro' being derived from the characteristic spiroketal side-chain of the steroidal sapogenins. In agreement with Klyne, I (rings *A*/*B* *cis*; 'normal' or 'neo' configuration[2] at C—22) is considered the basic structure, employing the usual steroid numbering system and other trivial prefixes (*α*, *β*, *epi*, *iso*, *allo*, etc.) as outlined by the Fiesers[3]. It should be noted that the term 'spirostan' includes by definition the two oxygen atoms without giving them a functional meaning in the name; this seems unobjectionable, since the two oxygen atoms cannot enter into any reaction unless the spiroketal ring is opened, whereupon the furostan (*b*) or open side-chain (*c*) nomenclature has to be used. Typical examples are given in Table 1 to illustrate the various isomeric forms which are possible.

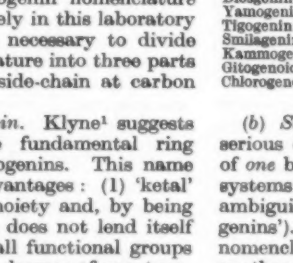
Table 1. Spirostan Derivatives

Old nomenclature	New nomenclature
Desoxysarsasapogenin (I)	spirostan
Diosgenin (II)	Δ^5-22-*iso*spirosten-3*β*-ol
Yamogenin	Δ^5-spirosten-3*β*-ol
Tigogenin (III)	22-*isoallo*spirostan-3*β*-ol
Smilagenin	22-*iso*spirostan-3*β*-ol
Kammogenin (IV)	Δ^5-22-*iso*spirostene-2,3-diol-12-one
Gitogenoic acid (V)	22-*isoallo*-2[3-spirostan-2,3-dioic acid[3]
Chlorogenoic acid	22-*isoallo*-2[3-spirostan-6-one-2,3-dioic acid[3].

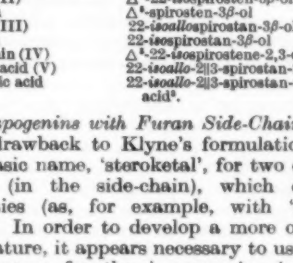
(*b*) *Sapogenins with Furan Side-Chain.* The most serious drawback to Klyne's formulation is the use of *one* basic name, 'steroketal', for two different ring systems (in the side-chain), which can lead to ambiguities (as, for example, with 'dihydrosapogenins'). In order to develop a more or less logical nomenclature, it appears necessary to us to introduce another name for the ψ-sapogenin ring system, a typical though not as striking precedent from steroid nomenclature being 'androstane' and '*allo*pregnane' (instead of 17-ethylandrostane). We propose the term 'furostan' for the ring system VI, the prefix 'furo' emphasizing the presence of a tetrahydrofuran



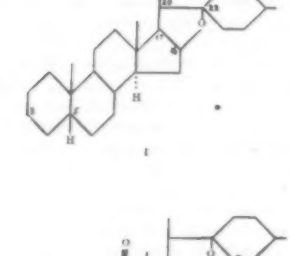
I



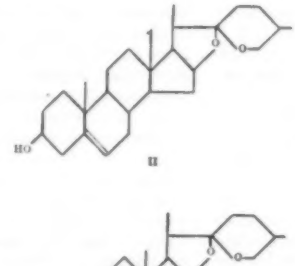
II



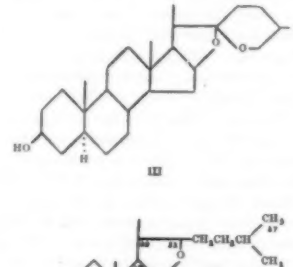
III



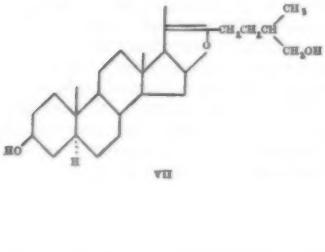
IV



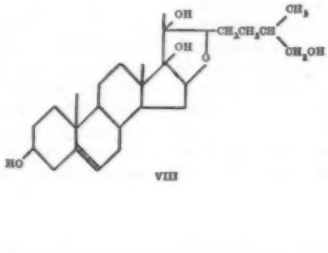
V



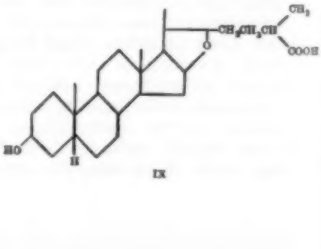
VI



VII



VIII



IX

ring in the side-chain. Some typical examples illustrating the use of 'furostan' are collected in Table 2.

Table 2. FUROSTAN DERIVATIVES

Old nomenclature	New nomenclature
ψ-Tigogenin (VII)	$\Delta^{25(27)}$-*allo*furostene-3β,26-diol
Dihydro-ψ-tigogenin	*allo*furostan-3β,26-diol
Dihydrotigogenin	20,22-*isoallo*furostan-3β,26-diol
ψ-Kammogenin	$\Delta^{5,20(22)}$-furostadiene-2,3,26-triol-12-one
ψ-Kryptogenin	$\Delta^{5,10,20(22)}$-furostatriene-3β,26-diol
16-Dihydrokryptogenin[4] (closed form)	Δ^{5}-furostene-3β, 22,26-triol
Nologenin (VIII)	Δ^{5}-furostene-3β,17,20,26-tetrol
Anhydrotetrahydrosarsasapogenoic acid (IX)	furostan-3β-ol-26-oic acid

Two points in regard to this nomenclature require comment. The furostan nucleus (VI) by definition does *not* contain the 26-hydroxyl group, since otherwise various functional derivatives (for example, the acid IX) could not be named (this objection applies to Klyne's 'ψ-steroketal'). Furthermore, a term such as 'ψ-steroketal', which by definition *includes* the 26-hydroxyl group without giving it a functional meaning in the name, possesses the disadvantage that a diacetate, such as that of VII, would somewhat obscurely be named '3-hydroxy*allo*-ψ-steroketal diacetate'. 'Dihydrosapogenins'[5] are believed to have the furostan ring system and to differ only from the dihydro-ψ-sapogenins by isomerism at C—20 and/or C—22. Since the structure of these 'dihydrosapogenins' has not been definitely proved, they are referred to for the time being as 20,22-*iso*furostan derivatives, thus illustrating that, in spite of the misleading term 'dihydrosapogenin', they possess the furostan and not the spirostan nucleus.

(c) *Sapogenins with 'Open' Side-Chain.* In full agreement with Klyne[1], we feel that all such compounds should be named as derivatives of cholestane or coprostane. In addition to tetrahydrosarsasapogenin[1], the following examples of sapogenin derivatives falling into this classification should be mentioned: kryptogenin and ricogenin (12-ketokryptogenin), the 'diosones'[5], the hypothetical 'pronologenin'[5] and the sapogenoic acids[3].

Only two types of sapogenin derivatives do not fall within any of the above three classifications, the anhydrosapogenoic acids[3] and the artefact 'fesogenin'[3]. Both contain the same ring skeleton, a *cyclo*pentenone ring fused to C—16 and C—17; but in view of their relative unimportance no name is suggested for this ring system at present. Should such substances eventually prove to be of importance, or should many such representatives be synthesized in the future, then this omission could be remedied readily by introducing a new basic term with the ending 'ane'.

In the original draft of this paper, we had suggested the terms 'spirostane' and 'furostane'. We are indebted to Dr. W. Klyne for having pointed out that the terms 'spirostan' and 'furostan' (without a terminal 'e') are more rational since the structures are not hydrocarbons (cf., pyran, furan).

G. ROSENKRANZ
CARL DJERASSI

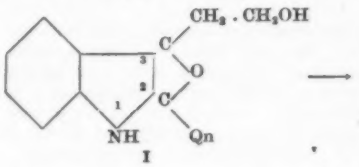
Research Laboratories, Syntex, S.A.,
Laguna Mayran 413, Mexico City, D.F. March 23.

[1] Klyne, W., *Nature*, **165**, 313 (1950).
[2] Fieser, L. F., and Fieser, M., "Natural Products Related to Phenanthrene" (3rd edit. New York: Reinhold, 1949); steroid nomenclature: pp. vi–viii; sapogenins: pp. 578–96.
[3] Based on the bilianic acid nomenclature of Sobotka, H., "Chemistry of the Sterids", 164 (Baltimore: Williams and Wilkins Co., 1937).
[4] Kaufmann, St., and Rosenkranz, G., *J. Amer. Chem. Soc.*, **70**, 3502 (1948).
[5] Marker, R. E., *et al.*, *J. Amer. Chem. Soc.*, **64**, 1655 (1942); **69**, 2218 (1947).

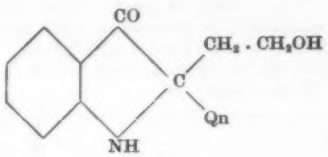
Mechanism of the Rearrangement of Quinamine to *Iso*Quinamine

THE transformation of quinamine to *iso*quinamine is brought about by the action of hot *iso*amyl alcoholic sodium *iso*amyloxide on quinamine[1]. (We have found that, under milder conditions with ethanolic sodium ethoxide, the alkaloid is first epimerized with partial formation of epiquinamine, almost certainly identical with conquinamine.)

Recent researches[2] have shown that quinamine (I, Qn = quinuclidine rest) yields *iso*quinamine (II) as the result of an intramolecular rearrangement of an unusual type in that the reagent is a base.

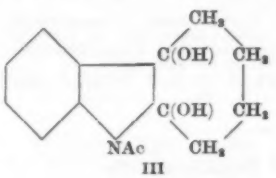


I

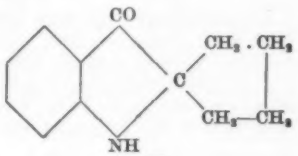


II

Until last year there was no close analogy for this; but it is now known that (III) is converted into (IV) under similar conditions[3].

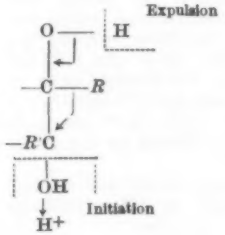


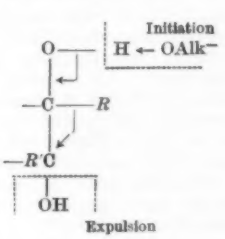
III



IV

The simplest view of the mechanism is an anionoid version of the pinacol rearrangement, which is catalysed by acids. In both cases an ion goes in at one point and out at another, with consequent rearrangements of identical form in the portion of the molecule between these centres.





It is a 'pull' in the first case and a 'push' in the second.

The process in III is assisted by the known lability of OH in the system N—C—OH.

The rearrangement of I to II is evidently parallel to that of III to IV and it is tempting to assume hydrolysis of the epoxide to a glycol so as to achieve a precise analogy. However, the reaction may be more direct and dependent on the loss of one of the available protons (on NH, or OH) and on the stability of the anion so produced. The charge may then be transferred to the epoxide oxygen, which is enabled to break away from C_2 and take the covalency electrons with it, the rearrangement following automatically.

We take this opportunity of making a preliminary announcement of the synthesis of cinchonamine (formula of Prelog *et al.*[3]) *via* quinamicine by coupling of tryptophol with meroquinene. Quinamicine is crude quinamidine, and we have not yet confirmed one link in the synthetic chain, namely, the recorded transformation of quinamicine into apoquinamine.

Note added in proof. Quite recently Witkop has modified the quinamine formula so as to include a furanoid ring and hydroxyl in position-3. This is acceptable and in the above 'epoxide' should be 'cyclic ether'.

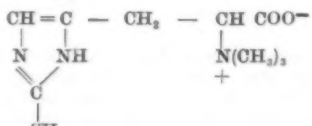
C. C. J. Culvenor
L. J. Goldsworthy
K. S. Kirby
R. Robinson

Dyson Perrins Laboratory,
University of Oxford.
March 13.

[1] Kirby, *J. Chem. Soc.*, 735 (1949).
[2] Kirby, *J. Chem. Soc.*, 528 (1945). Goutarel, Janot, Prelog and Taylor, *Helv. Chim. Acta*, **33**, 150 (1950). Bendz, Miss G., Culvenor, Goldsworthy, Kirby and Robinson; Paul Karrer Festschrift, Zurich (1949); *J. Chem. Soc.* (in the press, 1950).
[3] Plant and Robinson, *Nature*, **165**, 36 (1950). cf. Witkop, *J. Amer. Chem. Soc.*, **72**, 614 (1950).

Synthesis of Ergothioneine

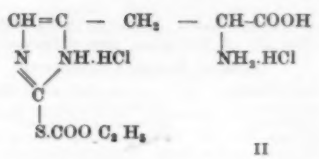
Ergothioneine has been isolated from ergot[1] and from mammalian blood[2,3]. Barger and Ewins[4] and Akabori[5] showed that the structure of ergothioneine (I) is β-2-thiolglyoxaline-4(5)-propiobetaine. This structure has now been confirmed by synthesis according to the following scheme.



I

2-Thiol histidine was prepared by Ashley and Harington's[6] method with modifications which improved the yield (120 gm. histidine monohydrochloride monohydrate yielded 21·0 gm. 2-thiol histidine). By treating with chlorformic ester in absolute alcohol, this was converted to 2-S-carbethoxy histidine dihydrochloride (II) (m.p. 189°, dec.), in which the sulphur atom was protected by the easily removable carbethoxy group.

Methylation of (II) with silver oxide and methyl iodide gave the silver complex of 2-S-carbethoxy histidine betaine.



II

Found: C, 33·4; H, 4·9; N, 12·5; S, 9·6; Cl, 21·2 per cent
Calc.: C, 32·5; H, 4·6; N, 12·6; S, 9·6; Cl, 21·3 per cent

Boiling with 3 *N* hydrochloric acid brought about hydrolysis and decarboxylation. The solution was freed from silver with hydrogen sulphide and the ergothioneine (I) isolated as a phosphotungstate, by precipitation with 10 per cent phosphotungstic acid in 5 per cent sulphuric acid. This was decomposed with baryta, excess baryta being removed with an equivalent amount of sulphuric acid. The ergothioneine thus obtained was twice recrystallized from aqueous alcohol (m.p. 290° decomp.).

Found: C, 47·1; H, 6·7; N, 18·3; S, 14·0 per cent
Calc.: C, 47·1; H, 6·6; N, 18·3; S, 14·0 per cent

In the following tests, synthetic ergothioneine and specimens of ergothioneine from blood (Hunter) and ergot (Lawson) showed identical behaviour: Hunter's[7] diazo test, sulphur dioxide in acid solution, gold chloride, iodine in potassium iodide solution, mercuric chloride solution, and Mayer's alkaloid reagent. On warming with 2 *N* sodium hydroxide, trimethylamine was evolved leaving a yellow solution. Addition of Folin–Marenzi's uric acid reagent to a solution in sodium carbonate produced an immediate blue colour.

No differences in R_F values were detected when natural and synthetic ergothioneine were subjected to paper partition chromatography[8] in collidine or in phenol.

The ultra-violet absorption spectra in water were identical, with a maximum at 258 mμ, $E^{1\,cm.}_{mol.} = 1{\cdot}6 \times 10^4$. A full report of this work will be published elsewhere.

We wish to express our gratitude to Mr. P. R. E. Wallace for technical assistance throughout the synthesis, to Dr. E. Work and Mr. F. Grover for the paper chromatograms, to Dr. G. Hunter for help in isolation in the final stages, and to Drs. Weiler and Strauss of Oxford for the microanalyses. This work was performed during the tenure by one of us (H. H.) of a British Drug Houses Research Fellowship.

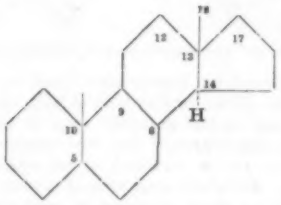
H. Heath
A. Lawson
C. Rimington

Department of Chemical Pathology,
University College Hospital Medical School,
London, W.C.1,
and
Department of Chemistry,
Royal Free Hospital School of Medicine,
London, W.C.1.
May 26.

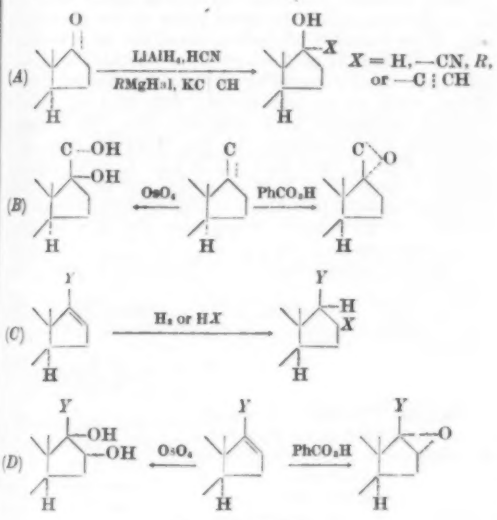
[1] Tanret, G., *J. Pharm. Chim.*, **30**, 145 (1909).
[2] Hunter, G., and Eagles, B. A., *J. Biol. Chem.*, **72**, 123 (1927).
[3] Newton, E. B., Benedict, S. R., and Dakin, H. D., *J. Biol. Chem.*, **72**, 367 (1927).
[4] Barger, G., and Ewins, A. J., *J. Chem. Soc.*, **99**, 2336 (1911).
[5] Akabori, S., *Ber. deut. chem. Ges.*, **66**, 151 (1933).
[6] Ashley, J. N., and Harington, C. R., *J. Chem. Soc.*, 2586 (1930).
[7] Hunter, G., *Biochem. J.*, **22**, 4 (1928).
[8] Work, E., *Lancet*, (i), 652 (1949).

Stereochemical Course of Reactions at Steroid C_{17}

EARLY in 1948, I discussed by letter with Prof. L. F. Fieser the stereochemical course of reactions at, or adjacent to, C_{17} of the steroid nucleus. The experimental facts may be summarized as follows[1].



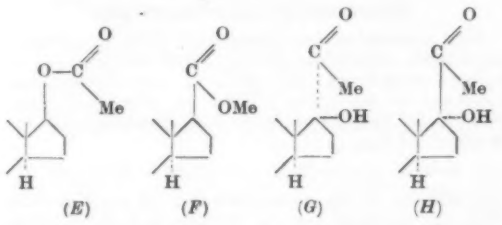
Steroids with normal configuration at C_{14} undergo reactions exemplified by *A*, *B*, *C* and *D* to afford largely or almost exclusively a single 17-epimeride in which the persisting extracyclic C_{17}-valency bond is β-orientated :



These results suggest that there is greater ease of attack from behind the general plane of the steroid ring system. The portion of the steroid nucleus involving C_{12}, C_{13}, C_{14}, C_{16}, C_{17}, C_{18}, constitutes an α-methyl*neo*pentyl system, and bimolecular processes in structures of *neo*pentyl type are subject to drastic steric hindrance at the α-carbon atom[2]. The above examples *A*, *B*, *C*, *D* are bimolecular reactions ; steric hindrance will thus be highly effective at C_{17}, and, since the groups mainly responsible (C_{13}, C_{14}, and particularly the β-orientated angular C_{18}) occupy fixed positions, it is clear that the effect will be more marked to the front and less marked to the rear of C_{17}.

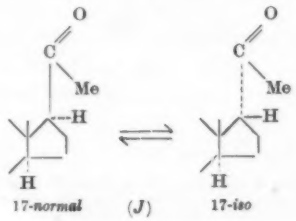
There is, however, a further factor in the stereochemical situation at C_{17} ; asymmetric synthesis must occur as the consequence of the combined action of the six nuclear asymmetry centres at C_3, C_8, C_9, C_{13}, C_{14} and C_{16}. Because these asymmetry centres occupy fixed positions, relative to C_{17}, in a rigid polycyclic system, the asymmetric synthesis effect may be expected to be considerable. It seems, therefore, probable that the observed results in reactions *A*, *B*, *C*, *D* may reflect not only steric hindrance but also asymmetric induction. There appears to be some evidence that elimination or inversion of configuration of one or more of the nuclear asymmetry centres alters the stereochemical course of reactions at C_{17}, and supplementary evidence is being sought by experimental examination of suitable examples. Asymmetric synthesis may be expected to occur at other positions in the steroid nucleus, and since there is a secondary *neo*pentyl system ending at C_{13} and two tertiary *neo*pentyl systems ending at C_8 and C_{14} respectively, at these positions asymmetric induction may be superposed on steric hindrance.

In striking contrast to reactions *A*, *B*, *C*, *D*, another group of reactions, exemplified by *E*, *F*, *G* and *H*, suggest that there is greater ease of attack from the front of the general plane of the ring system. Thus, in the alkaline hydrolysis (S_N2) of 17-epimeric acetates (*E*) and carboxylic esters (*F*), the rates are 17β > 17α ; similarly, in 17β-hydroxy-20-ketones (*G*) the hydroxyl group is invariably readily acetylated, but the carbonyl group does not afford ketonic derivatives, whereas in 17α-hydroxy-20-ketones (*H*) the hydroxyl group cannot be acetylated, while the carbonyl group possesses normal ketonic reactivity :



These reactions, unlike *A*, *B*, *C*, *D*, take place not at C_{17} but at adjacent atoms ; there is at least one more atom between the point of attack of the nucleophilic reagent and the groups which are mainly responsible for steric hindrance. *Neo*pentyl halides cannot be prepared from primary or secondary *neo*pentyl alcohols[3] ; but *neo*pentyl carboxylic esters are formed and hydrolysed at normal rates[4]. It is clear, therefore, that the steric hindrance effect discussed in relation to reactions *A*, *B*, *C*, *D* cannot operate in connexion with reactions *E*, *F*, *G*, *H*. Because there is 'free' rotation about the extracyclic valency bond of C_{17}, the reactions *E*, *F*, *G*, *H* should also be relatively immune from the asymmetric influence of the steroid nucleus.

The foregoing discussion of steric hindrance effects is essentially kinetic ; a more compelling argument may be derived from the equilibrium exemplified by *J* :



The equilibrium constant K in numerous cases largely favours the 17-*normal*-compound; since the decrease of free energy is given by $-\Delta F^{\circ} = RT \ln K$, this is the thermodynamically stable isomeride, so that, independently of the mechanisms of the processes involved, the net effect of all factors operating is to favour β-orientation of the acetyl group. An analogous argument can be adduced for the case of a 17-carbomethoxy group. The equilibrium (J) is thus related to reactions A, B, C, D inasmuch as C_{17} is directly involved, but conforms to the reactions E, F, G, H because the acetyl group lies outside the range of the effects, discussed above, due to steric hindrance and asymmetric induction; it shows that the 17β-acetyl group is more attracted or, conversely, that the 17α-acetyl group is more repelled, by other groups, although the source of such attraction or repulsion is obscure.

C. W. Shoppee

University College, Swansea,
University of Wales.
March 10.

[1] Cf. Fieser, L. F., and Fieser, M., "Natural Products Related to Phenanthrene", 410, 411 (3rd edit. New York: Reinhold, 1949).
[2] Dostrovsky, Ingold and Hughes, *J. Chem. Soc.*, 173 (1946).
[3] Whitmore and Rothrock, *J. Amer. Chem. Soc.*, **54**, 343 (1932).
[4] Quayle and Norton, *J. Amer. Chem. Soc.*, **62**, 1170 (1940).

Structure of *Trans*-Potassium Dioxalato-Diaquo-Chromiate

The crystals of *trans*-potassium dioxalato-diaquo-chromiate, $K[Cr(C_2O_4)_2(H_2O)_2].3H_2O$, are dark red in colour, very hard, and show a very pronounced tendency to intergrow. They are monoclinic, and from X-ray measurements the size of the unit cell was determined as:

$a = 7{\cdot}85$ A., $b = 5{\cdot}72$ A., $c = 13{\cdot}88$ A., $\beta = 109° 30'$.

The density of the compound is 2·02 gm./c.c. The unit cell contains two of the above formula units, and the space group is $P2/c$ (C^4_{2h}).

For an accurate determination of the structure the method of double Fourier series was used. Fig. 1 shows a projection of the structure on the *ac*-plane when viewed parallel to *b*. A second projection on the *bc*-plane made it possible to assign co-ordinates to all the atoms. Fig. 2 shows the dimensions of the $[Cr(C_2O_4)_2(H_2O)_2]$ complex ion. The two water molecules, marked H_2O (1), in this complex ion are at distances 2·02 A. from the chromium atom. The line joining them is perpendicular to the plane in which the two oxalato groups of the complex ion is found to lie. The dimensions in Fig. 2 can be compared

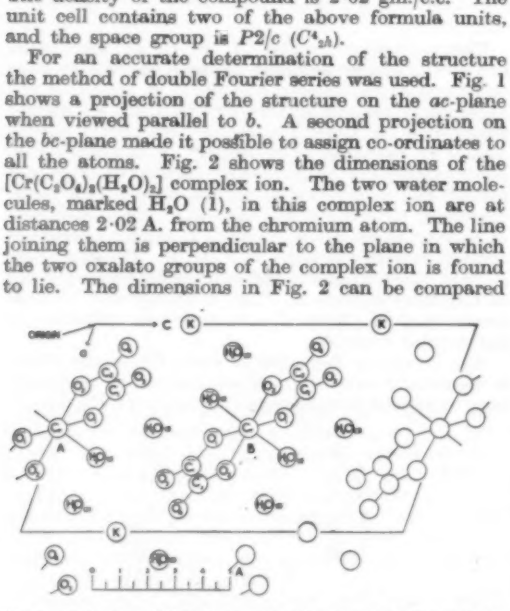


Fig. 1. Projection of the structure in direction *b* on the *ac*-plane. A formula unit marked *B* is derived from one marked *A* by the operation of a glide plane parallel to (010)

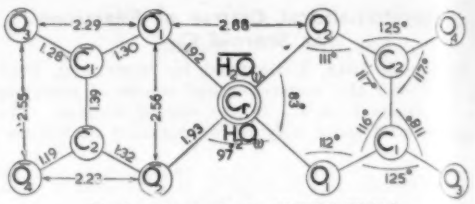


Fig. 2. The complex ion $[Cr(C_2O_4)_2(H_2O)_2]$

with those found by Zachariasen[1] and by Robertson and Woodward[2] for oxalic acid dihydrate.

The packing of the complex ions in the structure is such that the plane of the two oxalato groups in each complex ion is inclined at an angle of 61° to the *ac*-plane, while the long axis of a planar $Cr(C_2O_4)_2$ group makes an angle of about 9° with the *ac*-plane. Each potassium ion is surrounded by eight oxygen atoms, six of these oxygens approaching a potassium ion to within a distance of 2·74 A., the other two approaching it to within a distance of 3·10 A. The eight oxygens surrounding a potassium ion are parts of four different formula units, and these units all lie in approximately the same plane as the potassium ion. If we consider formula units of the type marked *A* and *B* (Fig. 1) to form an approximate layer-like structure, then it seems likely that the binding forces within such layers are mainly due to ionic bonds between potassium and complex ions. The water molecules not belonging to the complex ions, and marked H_2O (2) and H_2O (3) in Fig. 1, form zig-zag chains of length 2·66 A. running through the structure from one layer to the other, so that hydrogen bonding appears to be largely responsible for the binding forces between such layers.

A detailed description of this work will be published elsewhere.

This note is published by permission of the South African Council for Scientific and Industrial Research.

J. N. van Niekerk
F. R. L. Schoening

National Physical Laboratory,
South African Council for
Scientific and Industrial Research,
Pretoria.
March 25.

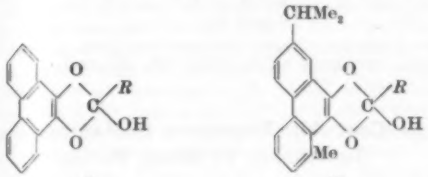
[1] Zachariasen, *Z. Krist.*, **89**, 422 (1934).
[2] Robertson and Woodward, *J. Chem. Soc.*, 1817 (1936).

Reactions of 9-Anthraldehyde in Sunlight

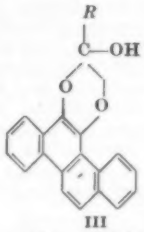
The investigations recently reported[1] have been continued, and I wish to put the following facts on record. The photo-experiments mentioned below have been carried out in a sealed 'Monax' or 'Pyrex' glass tube (Schlenk tube) in an atmosphere of dry carbon dioxide; in all cases the dark experiments were negative.

(*a*) A number of photo-reactions between phenanthraquinone and aromatic aldehydes has been described[1]. A similar reaction has been carried out between 9-anthraldehyde and phenanthraquinone, retenequinone and chrysoquinone respectively, affording 9-anthrylhydroxymethylene ether of 9 : 10-dihydroxyphenanthrene (I), melting point 228° from xylene (found: C, 84·1; H, 4·3; *M* (micro-Rast), 401. $C_{29}H_{18}O_3$ requires C, 84·1; H, 4·3 per cent; *M*, 414), 9-anthrylhydroxymethylene ether of 9 : 10-

dihydroxyretene (II), melting point 187° from benzene (found : C, 84·1 ; H, 5·3. $C_{33}H_{26}O_2$ requires C, 84·3 ; H, 5·5 per cent), and 9-anthrylhydroxymethylene ether of 1 : 2-dihydroxychrysene (III), melting point 190° from xylene (found : C, 85·0 ; H, 4·2. $C_{33}H_{20}O_3$ requires C, 85·3 ; H, 4·3 per cent).



I II



III

(R = anthryl = $C_{14}H_9$)

(*b*) The photo-dimer of 9-anthraldehyde is formed when its benzene solution is exposed to sunlight. The substance, colourless crystals, melting point 250° (decomposition), forms 9-anthraldehyde on heating at 270° (bath temperature) in a stream of dry carbon dioxide (found : C, 87·6 ; H, 4·8. $C_{30}H_{20}O_2$ requires C, 87·3 ; H, 4·8 per cent).

When a solution of 9-anthraldehyde in *iso*propyl alcohol[2] is exposed to sunlight, colourless crystals, melting point 188°, of molecular formula $C_{32}H_{22}O_2$, were obtained (found : C, 86·7 ; H, 5·1 ; *M* (micro-Rast), 410. $C_{32}H_{22}O_2$ requires C, 87·0 ; H, 5·3 per cent : *M*, 414). The structure of the photo-product is under investigation.

AHMED MUSTAFA

Chemistry Department,
Faculty of Science,
Fouad I University,
Abbassia, Cairo.
March 9.

[1] *Nature*, **160**, 401 (1947) ; *J. Chem. Soc.*, 67, 387 (1944) ; 551, 657 (1945) ; 2126 (1948) ; *Nature*, **163**, 856 (1948) ; *J. Chem. Soc.*, 81, 83, 1039 (1949).

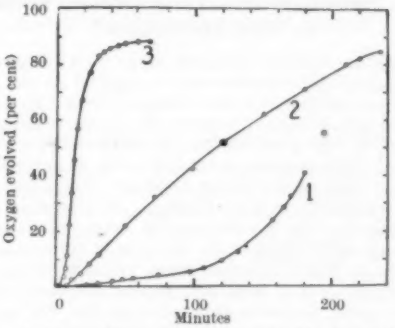
[2] Hinkel, Ayling and Beynon, *J. Chem. Soc.*, 339 (1936).

Thermal Decomposition of Potassium Perchlorate

PERCHLORIC acid is often determined as potassium chloride by repeated ignition of potassium perchlorate, mixed with excess ammonium chloride and in presence of platinum as catalyst. It is currently assumed that the reducing agent is the ammonia, though K. A. Hofmann and W. Linnmann[1] have shown that gaseous ammonia does not reduce perchlorate below 430° C.

According to L. Moses and S. Marian[2], ammonium bromide at 500° and ammonium iodide at 400° are far more effective than the chloride ; no catalyst is needed and two or three successive ignitions lead to quantitative reduction. These authors attribute the effect to the higher dissociation of hydrogen bromide and iodide, which supplies additional nascent hydrogen for the reduction.

In a study of the thermal decomposition of potassium perchlorate, it was observed that halides have an unexpectedly large influence on the rate of this reaction. The accompanying graph (per cent of oxygen evolved versus time) illustrates the effect at 525° C. ; bromide is more effective than chloride, and with the iodide the reaction is too fast to be measured. At 400°, very little oxygen is given off in presence of iodide, and the mixture is converted quantitatively into iodate, chlorate and chloride in a comparatively short time.



Thermal decomposition of potassium perchlorate at 525° C. Curve 1, $KClO_4$ pure ; curve 2, $KClO_4$ + KCl (1 : 1 by wt.) ; curve 3, $KClO_4$ + KBr (1 : 1 by wt.)

It appears, therefore, that the reduction of perchlorate by ammonium halides is due to a catalytic effect of the anion which increases with the atomic weight of the halogen ion. These experiments also shed some light on the formation of potassium bromide[2] on ignition of potassium perchlorate – ammonium bromide mixtures.

Analysis of the reaction products obtained by partial decomposition of pure perchlorate and its mixtures with potassium bromide and chloride has shown the presence of considerable amounts of chlorate (see table).

According to Hofmann and Linnmann[1], chlorates are reduced by ammonia at temperatures below, as well as above, 300° according to the following equations :

$$KClO_3 + 2NH_3 \rightarrow KCl + 2N + 3H_2O \quad (1)$$
$$KClO_3 + N \rightarrow KNO_3 + Cl, \quad (2)$$

yielding under favourable conditions up to 60 per cent of the theoretical amount of potassium nitrate.

If one makes the reasonable assumption that the same reactions occur with the nitrate formed from a perchlorate – ammonium bromide mixture, a reaction according to equation (3) should be expected :

$$KNO_3 + NH_4Br \rightarrow KBr + N_2O + 2H_2O. \quad (3)$$

PER CENT OF CHLORATE FOUND IN PARTIALLY DECOMPOSED PERCHLORATE

	$KClO_4$			$KClO_4$ + KCl			$KClO_4$ + KBr			
% $KClO_4$ decomposed	26·8	31·0	53·0	42·3	49·3	66·4	2·9	21·7	53·0	84·0
% $KClO_3$ found	6·28	6·9	7·3	4·7	5·0	8·3	1·9	9·4	5·3	0·8

This would explain the curious replacement of chlorine by bromine in the ignition of potassium perchlorate – ammonium bromide mixtures.

These experiments were carried out under the auspices of the Scientific Department, Israeli Ministry of Defence, and are published with its permission.

A. Glasner

Department of Inorganic and Analytical Chemistry, Hebrew University, Jerusalem.

L. Weidenfeld

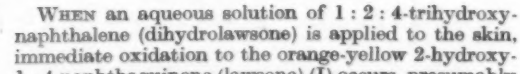
Scientific Department, Israeli Ministry of Defence.

March 9.

[1] *Ber.*, **57**, 818 (1924).
[2] *Ber.*, **59**, 1335 (1926).

Are Tyrosinase and Thiol Groups Present in Skin Epithelium?

When an aqueous solution of 1 : 2 : 4-trihydroxynaphthalene (dihydrolawsone) is applied to the skin, immediate oxidation to the orange-yellow 2-hydroxy-1 : 4-naphthaquinone (lawsone) (I) occurs, presumably because of the presence in the skin of an oxidase system. This enzyme is undoubtedly a polyphenol-oxidase; but since similar application of L-tyrosine, DL-3 : 4-dihydroxyphenylalanine, or catechol does not lead to the production of any colour, it is extremely unlikely that the enzyme is tyrosinase. It is known[1] that quinones react rapidly with thiol compounds, and it does not appear unreasonable to suppose that, if human skin contains free SH-groups, these would react with the lawsone deposited *in situ* in the above manner. If the lawsone is allowed to remain on the skin for twenty-four hours, the stain can be removed almost completely by washing with soap and water. Consequently skin appears to contain very few thiol groups.



The correctness of the latter view appears to be amply justified by the following simple—but often rather 'irritating'—experiment. The trihydroxynaphthalene is dissolved in a dilute aqueous solution of ammonium thioglycollate, and a little of this solution applied to the skin. There is usually produced a temporary 'blackening' together with, in some cases (according to the amount of ammonium thioglycollate used), a blister or weal. The dark colour disappears fairly rapidly; but a persistent deep-orange-coloured stain remains. This cannot be removed by washing; but removal of the epithelium removes the stain, too.

The explanation of the difference in intensity and fastness of the stain is undoubtedly as follows. The ammonium thioglycollate reduces some of the S.S bonds in the skin protein to SH groups, which then react with the oxidized trihydroxynaphthalene to give (II). This is then oxidized by the oxidase system to the quinone (III)[2], which is more deeply coloured than (I) and, since the group *R* is part of the skin protein, is much more permanent.

It is concluded that skin probably does not contain tyrosinase and few, if any, SH groups.

H. Burton
J. M. Williams

King's College of Household and Social Science, (University of London), London, W.8.

March 18.

[1] Fieser and Fieser, "Organic Chemistry", 738 (1944).
[2] Compare Burton and Stoves, *Nature*, **165**, 569 (1950).

Low-Cost Air Transport of Radioactive Substances to South Africa

The Atomic Energy Act 1948 of the Union of South Africa gave the Atomic Energy Board the sole right to import into the Union artificially made radioactive elements. The Board has designated the South African Council for Scientific and Industrial Research as its agent in this matter, and as a result its subordinate organisation, the National Physical Laboratory, has had to consider the problem of bringing into the Union, over a distance of six thousand miles, considerable quantities of radioactive elements the lives of which are so short that air transport is the only possible method.

With beta-ray emitters such as phosphorus-32, all that is necessary is a centimetre of light-weight absorber such as wood, and the Isotope Division, Atomic Energy Research Establishment, Harwell, is using such containers, so that importation of phosphorus-32 is a simple matter.

In the case of iodine-131, however, the gamma-radiation makes it necessary to provide a fair weight of lead shielding, and in the consignments which were imported into the Union during 1949 the average weight of the returnable container used has been twenty-five pounds, with even greater weights for large orders. In the case of sodium-24, which has a very high-energy gamma-radiation, an ionization function double that of radium and a half-life of only 14·8 hr., the importation of even one or two millicuries presented an insuperable difficulty, for the cost worked out at about £70 for freight alone.

It was therefore decided, late in 1948, to attempt to devise a scheme whereby the protective effect of distance was used instead of lead. Discussions were accordingly begun with (*a*) the Division of Civil Aviation of the Department of Transport of the Union Government, (*b*) the Ministry of Civil Aviation, United Kingdom, (*c*) the South African Airways. Our suggestions were well received by these organisations, and the Isotopes Division of the Atomic Energy Research Establishment at Harwell supported us very vigorously at every point.

Calculation showed that, since a *D.C.*4 aircraft has a wing span of more than a hundred feet, the intensity of ionization from one hundred millicuries of sodium-24 carried at the tip of the wing would be so low in the cabin that sensitive X-ray film could be carried in the aircraft for more than forty hours without reaching the lowest degree of blackening which can be tolerated in such film. In addition, it was established that the process of refuelling constituted no hazard to the person who controls the operation from a point on the wing between the two engines, and that the gamma-ray dose-rate at a point on the ground immediately below the wing tip was below tolerance-level. It was finally decided to limit all loads of any type of radioactive element to one

hundred millicuries, as this was satisfactory for sodium and would be more so for the lower-energy gamma-emitters; and this is the present limiting load for the Skymasters which operate on the Springbok route between London Airport and Palmietfontein (Johannesburg).

The South African Airways engineers designed a cylindrical receptacle which is built into the wing-tip of one wing of each *D.C.*4 aircraft. The metal cylinder has a large flange at its open end and this flange is riveted over an opening in the upper wing surface, so that when the flush snap-down lid of the receptacle is closed the lid and the flange form part of the upper surface of the wing, while the cylinder hangs down inside the wing. The receptacle is lined with sponge rubber, leaving a space just large enough to take a brass container with screw top and lifting eye, which in its turn contains the actual aluminium can which the Atomic Energy Research Establishment uses for transporting radioelements. A large number of the brass containers have been made, and after receipt of a shipment the container is immediately returned to the Atomic Energy Research Establishment by surface mail.

Carrying-cases of conventional design have been constructed for the transport by road of radioisotopes from Harwell to London Airport and from Palmietfontein to Pretoria. These cases are made of leather with fairly long leather handles and have a lead pot held in the centre of the case with a wooden framing. The Isotopes Division at Harwell, having packed a shipment into a brass container, places it in the lead pot by means of an extensible rod and hook (stored in the case) and delivers it to shipping agents at London Airport. Just before the aircraft is due to leave, the case is carried out to the aeroplane and the brass container is transferred to the wingtip receptable, again by means of the rod and hook. Unloading at Palmietfontein is carried out in a similar way, and it has been found that the whole unloading procedure can be finished in forty seconds.

The major mishaps which have to be guarded against are: (1) a grounding of an aircraft at one of the intermediate stops, (2) a serious crash. In the case of (1), the standing instructions to airport engineers are that they should do nothing if the grounding period is less than twenty-four hours; but that if this period is exceeded or if work has to be done on the wingtip itself, then the container should be removed by means of an improvised hooked stick and either transferred to a relief aircraft or placed in an open space until the aircraft is ready for service again. In the case of (2), the instructions are that a salvage party arriving at the aircraft should bury the container and abandon it. This is reasonable, because any consignment of high activity would be of short life, whereas only small activities of long-lived radioelements will be carried in this way.

The scheme, which provides for the carrying of up to 100 millicuries of any radioactive element in one shipment, has now operated for three months and a number of shipments of iodine-131 have been received. Three shipments of sodium-24 have also been received, and it was found possible to land more than twelve millicuries in the National Physical Laboratory at an air-freight cost of eighteen shillings plus agents' fees of £3 5*s*. and other extras amounting to £1 5*s*.

The success of the scheme seems now to be assured, and it is possible to contemplate carrying out experiments involving radioelements the import of which would have been impossible by any other means.

We should like to express our appreciation to the Isotopes Division of the Atomic Energy Research Establishment, Harwell, where the staff gave us most enthusiastic support, to the Division of Civil Aviation of the South African Department of Transport, which overcame endless problems in the process of getting approval for national and international regulations necessary for such a scheme, to the United Kingdom Ministry of Civil Aviation for advice and prompt assistance, and to the Engineers Section of the South African Airways for their handling of the mechanical problem.

This note is published by permission of the South African Council for Scientific and Industrial Research.

E. C. Halliday
Tikvah Alper
South African National Physical Laboratory,
Council for Scientific and Industrial Research,
Pretoria.
May 10.

Ultra-violet Radiation in the Sea

During the Swedish Deep-Sea Expedition with the *Albatross*, measurements of sub-surface radiation were carried out in different areas, chiefly by means of photo-electric methods. Special attention was given to the study of the biologically important short-wave part of the spectrum. The range beyond 315 mμ with anti-rachitic effects was determined by means of a special technique. Two liquid filters, namely, 18 mm. saturated nickel sulphate solution and 14 mm. picric acid solution (45 mgm. per litre), are used, together with a 6-mm. *UG*5 glass from Schott und Genossen. These filters are combined with a selenium rectifier cell adapted for the ultra-violet, the liquids being enclosed between three concentric hemispherical quartz shells around the cell covered by the *UG*5 glass. The centre of gravity for the measured radiation is estimated at 310 mμ. The photometer is connected to an Ising galvanometer with a sensitivity of 4×10^{-10} amp. per scale unit.

The infra-red leakage of the filters proved to be negligible, neither did the photometer react to visible light nor to the near ultra-violet.

Experiments were limited to the uppermost 15 m., but could be conducted also in off-shore waters in the West Pacific Ocean and in the Mediterranean. The results were surprising in that ocean water was found to be much more transparent to the anti-rachitic ultra-violet radiation than has been assumed. In the East Mediterranean, where the clarity of the water equals that of the Sargasso Sea, the ultra-violet radiation at 310 mμ was reduced by only 14 per cent per metre depth, the sun being at altitude 62°. For the near ultra-violet at 375 mμ, the corresponding value was 5 per cent, and for the blue at 465 mμ, 3 per cent, which agrees well with earlier results found with pure sea water[1].

Considering that the rate of absorption of the anti-rachitic ultra-violet in the Skagerrak off the Swedish west coast is normally more than 90 per cent per metre depth[2], the penetration in the oceans stands out as very effective. The fundamental difference, also manifest in the colour of the sea, is attributed to the dissolved 'yellow substance' which is abundant

in Swedish waters but almost absent in the clearest ocean water.

This high transparency of the oceans to the biologically important ultra-violet radiation would mean that the active region, where photochemical processes can be carried on, extends as far down as 20 metres.

N. G. JERLOV

Oceanographical Institute,
Gothenburg.
March 7.

[1] Clarke and James, *J. Opt. Soc. Amer.*, **29** (1939).
Johnson, *Medd. Oceanografiska Inst., Göteborg*, **8** (1946).
[3] Kalle, *Ann. Hydr. Mar. Met.*, **66** (1938).

Isotopic Composition of the Oxygen in Silicate Rocks

NATURAL oxygen, which forms about 50 per cent of the earth's crust, contains one heavy atom (O^{18}) in almost exactly 500 atoms of the light isotope (O^{16}). There exists, however, an appreciable isotopic differentiation which may be as high as some 4 per cent of the natural ratio and which has been studied extensively by Dole[1], Urey[2] and many others[3]. Nevertheless, we know very little about the distribution of the oxygen isotopes in the lithosphere. Only a few of the more abundant rocks such as limestones and iron ores have been investigated; but nothing is known about silicate rocks, which form about 99 per cent of the outer shell of the earth. It is obvious that the study of the oxygen isotope abundances in silicate rocks may yield valuable geological information.

To prepare the oxygen samples we used a method which was applicable to all the different kinds of silicate rocks and which led to their complete decomposition forming gaseous oxygen. Complete decomposition turned out to be necessary in order to avoid isotopic fractionation and to obtain consistent results. The finely ground rock sample was mixed with about the same amount of platinum powder and treated with a mixture of chlorine trifluoride and anhydrous hydrofluoric acid in a nickel reaction tube. The reaction took place at 430° C. over a time of about twenty hours.. The reaction mixture, containing metal halides, silicon tetrafluoride, chlorine trifluoride, hydrogen fluoride, chlorine and oxygen, was cooled with liquid nitrogen, leaving only the oxygen at a sufficient vapour pressure to be pumped off in a sample tube. The yields of oxygen obtained in this way were always close to 100 per cent. The isotopic composition was determined by means of a Nier-type double-collector mass-spectrometer of very high sensitivity[3]. All samples were compared with the same standard sample of oxygen, and the deviations of the ratios in parts per mil are listed in the accompanying table, positive figures indicating more, negative figures less, of the heavy isotope oxygen-18 than in the standard.

The oxygen obtained from different runs on the same rock sample gave the same isotope analysis within about ± 1·5 per mil of the ratio. The ratio determination of an oxygen sample in the mass spectrometer was reproducible within ± 0·15 per mil.

Since it is not possible to get the oxygen from water with chlorine trifluoride we used fluorine, which led to complete decomposition. The separation of the oxygen from the excess fluorine was done by passing the mixture through a trap containing dry sodium bromide and freezing out the bromine with liquid air.

ISOTOPIC COMPOSITION OF OXYGEN IN SILICATE ROCKS
(deviations of the ratio from the standard in parts per mil)

Igneous rocks	
Gneissic granite (Pre-Cambrian, South Dakota) standard	0·0
Greenland basalt (containing metallic iron and platinum metals)	− 4·5
Obsidian glass (Iceland)	− 4·5
Basalt (Columbia River, Oregon)	− 1·5
Lavas (recent) Etna	− 1·5
Parícutin	− 0·5
Hawaii	− 1·5
Sedimentary rocks	
Wiahart orthoquartzite (Pre-Cambrian, Labrador)	+ 7·0
Cheshire orthoquartzite (Lower Cambrian, Vermont)	+ 2·5
Potsdam orthoquartzite (Upper Cambrian, Wisconsin)	+ 4·0
Arkose (Triassic, Connecticut)	+ 2·0
Moquoketa-shale (Upper Ordovician, Iowa)	+ 6·5
Dover flint (Cretaceous, England)	+15
Diatomite (Miocene, California)	+22
Meteorites	
Java tektite	+ 1·0
Moldavite (Hungary)	+ 3·0
Darwin glass (Australia)	+ 7·0
Miscellaneous	
Fresh water (Lake Michigan)	−12·5
Sea water (Hawaii)	− 8·5
Tank oxygen (air)	+23

From the fact that sedimentary rocks are in all cases richer in heavy oxygen than igneous rocks, we conclude that there was an exchange of oxygen between the surface of the silicate and the water during the time of erosion and sedimentation. From the figures for sea water and diatomite (silica which was precipitated from solution) we can estimate the equilibrium constant of this exchange reaction to be $K = 1{\cdot}03$ at about 15° C. The high positive value for flint indicates a somewhat similar process of precipitation of dissolved silica. In all other sedimentary rocks measured, the amount of exchange is much lower, since only the surface layers of the individual sand or clay particles were involved. A more detailed study of the depth to which the exchange took place in this case should throw some light upon the time of contact with water.

Since sedimentary rocks picked up heavy oxygen during their period of formation from igneous rocks, the water must have lost the same total amount of oxygen-18. We can therefore estimate roughly by how much the isotopic ratio of the seas has changed since the time when the crust of the earth solidified and the process of erosion started. It is reasonable to assume that there was no isotopic differentiation worth mentioning when the surface of the earth was at a high temperature of about 2,000°. From the results obtained for the different basalts and lavas we get an average of about − 2 per mil, which should be very close to the primordial composition of the oxygen in the water vapour and the molten silicates. At present, sea water shows a composition of − 8·5 per mil, indicating that the isotopic ratio of the oxygen in the seas has decreased by some 6·5 per mil since the early days.

On the other hand, we know from several estimates[4] that the total amount of oxygen in sedimentary rocks is of the same order of magnitude as the oxygen content of the hydrosphere. Therefore the sedimentary rocks should show an isotopic ratio which is on the average some 6·5 per mil higher than that in the igneous rocks. This figure is in good agreement with our measured abundances.

It is, of course, not possible to draw too detailed conclusions from our few measurements. Thus, for example, we do not know how to account for the slight differences in the isotope ratio of the various

igneous rocks. The abundance of oxygen-18 seems to decrease with increasing depth, as shown by the sequence: gneissic granite, 0·0; lavas, − 1; Greenland basalt, − 4·5. The tektites, which are supposed to be of meteoric origin, have varying isotopic composition, all, however, falling into the range of the terrestrial abundances.

One of the most important applications of the accurate oxygen isotope ratio determinations in silicate rocks would be the possibility of distinguishing between real igneous rocks and meta-sedimentary rocks.

I am much indebted to Prof. H. C. Urey who suggested this problem, for his interest and many helpful discussions. I wish to thank Mr. Sol R. Silverman, of the Geology Department, for his help and for furnishing most of the rock samples.

The work was supported by a fellowship of the Swiss Foundation "Stiftung für Stipendien auf dem Gebiete der Chemie" and a grant-in-aid from the University of Chicago.

PETER BAERTSCHI

Institute for Nuclear Studies,
University of Chicago.
(Present address:
Physikalisch-Chemische Anstalt,
Universität, Basel.)

Feb. 26.

[1] Dole, M., *J. Amer. Chem. Soc.*, **58**, 693 (1936); *ibid.*, **62**, 471 (1940); *Science*, **109**, 77 (1949).
[2] Urey, H. C., *J. Amer. Chem. Soc.*, **56**, 2601 (1934); *Science*, **108**, 489 (1948).
[3] Reviewed by M. D. Kamen, *Bull. Amer. Mus. Nat. Hist.*, **87**, 103 (1946).
[4] Pettijohn, F. J., "Sedimentary Rocks" (Harper and Bros., 1949).

Applications of Polarimetry to Infra-Red and Micro-Wave Spectroscopy

G. HERZBERG and other investigators[1] have recently shown that vibrational motions of homopolar molecules which should not appear in infra-red absorption give rise to absorption lines when the substance is in a condensed state (compressed gas or liquid) and when the absorption path is long enough. As the selection rules are the same as for Raman spectra, and as this absorption seems to be dependent on intermolecular forces, it seems natural to attribute it to electric moments induced in the molecules by intermolecular electric fields. The theory of electric moments induced in molecules by a macroscopic electric field can easily be derived from the classical theory of the Raman effect by substituting a constant field vector **E** for the vibrational field $\mathbf{E} = E_0 \sin 2\pi\nu t$ of the incident light wave, and this shows immediately that the induced absorption is governed by the same polarizability-tensor as the Raman effect. While I was developing this theory in a recent note[2], my attention was directed to two papers dealing with the same subject: already in 1932 E. U. Condon[3] had developed the theory of this induced absorption by electric fields on a quantum-mechanical basis, and in a recent letter in *Nature*, L. A. Woodward[4] has pointed out that the powerful and precise methods of micro-wave spectroscopy could be extended to the study of pure rotational absorption of non-polar molecules.

I would like to emphasize that, as opposed to the absorption caused by molecular fields of random orientation, the absorption induced by macroscopic fields of fixed direction will be anisotropic, the vibration parallel to the field being always more strongly absorbed than the vibration perpendicular to it. The ratio of the absorption coefficients perpendicular and parallel to the electric field, which we may call the 'dichroism' factor f, is given by the same expression as the 'depolarization factor' ρ of the corresponding Raman lines excited by polarized light. As the numerical value of ρ may depend on the frequency of the incident light, f represents the limiting value of ρ for zero frequency, and so its value will give information on the dispersion of ρ. For totally symmetric vibrations such as the 991 cm.$^{-1}$ frequency of the benzene molecule, the anisotropy of absorption will be very marked, and for the totally symmetric vibrations of spherosymmetrical molecules (CH_4, CCl_4) only the vibration parallel to the field will be absorbed. For non-totally symmetric vibrations, vibration-rotation and pure rotation lines the dichroism factor will have the constant maximum value 0·75, so that the anisotropy of absorption will still be appreciable. Now it is a well-known fact, illustrated by crystal optics, that dichroism is connected with double refraction. So the induced absorption lines will give rise to a Kerr effect which will show resonance (enhancement and anomalous dispersion) in the neighbourhood of the critical frequencies. An incident wave polarized at 45° to the direction of the constant field will emerge as elliptically polarized, and as this is an interference effect, I believe that the use of a polarimetric device adapted to the infra-red and microwave region will be a very sensitive method for detecting resonance frequencies of molecules. In the neighbourhood of a critical frequency, the birefringence (difference of refractive index parallel and perpendicular to the field) will be of the order of

$$\Delta n \sim 2\pi N^{\sigma} \cdot \frac{g'}{g''} \frac{\mu_{\parallel}^2 - \mu_{\perp}^2}{h\Delta\nu},$$

where $\mu_{\parallel}$ and $\mu_{\perp}$ are the induced moments attached to the quantum transitions and $\Delta\nu$ the distance of the frequency under investigation from the resonance frequency; the maximum desirable effect will be obtained when $\Delta\nu$ is of the order of the line breadth. This gives for pure rotational transitions very small angles of ellipticity (of the order of 10^{-6} radian for fields of 30,000 volts/cm. and for 1 metre path in gases at atmospheric pressure, if $\Delta\nu \sim 0{\cdot}01$ cm.$^{-1}$). But in a resonant cavity when the wave is going many times to and fro, the effects will add up and marked depolarization of the wave near the resonance frequency will occur and might be detected.

Another phenomenon, paramagnetic resonance, is connected with the Faraday effect near the resonance frequencies[5] and could also be studied by polarimetric methods in the radio-frequency range.

Polarimetric measurements can be easily adapted to radio-frequency techniques in cylindrical wave guides or resonant cavities, and have already been so applied[6]. They will open up new fields of research in atomic and molecular spectroscopy.

A. KASTLER

École Normale Supérieure,
Paris.

May 18.

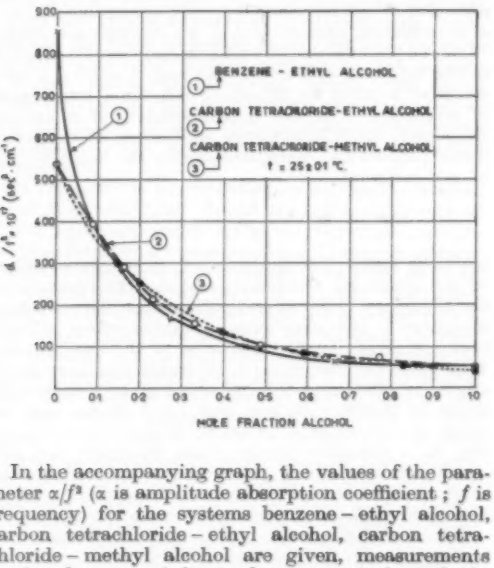
[1] Herzberg, G., *Nature*, **163**, 170 (1949). Crawford, Welsh and Locke, *Phys. Rev.*, **75**, 1607 (1949); **76**, 580 (1949). Oxholm, M. L., and Williams, A. D., *Phys. Rev.*, **76**, 151 (1949).
[2] Kastler, A., *C.R. Acad. Sci., Paris*, **230**, 1596 (1950).
[3] Condon, E. U., *Phys. Rev.*, **41**, 759 (1932).
[4] Woodward, L. A., *Nature*, **165**, 198 (1950).
[5] Kastler, A., *C.R. Acad. Sci., Paris*, **228**, 1640 (1949).
[6] Wilson and Hull, *Phys. Rev.*, **74**, 711 (1948).

Ultrasonic Absorption in some Mixtures of an Unassociated and an Associated Liquid

THE difference between classical and experimental values of ultrasonic absorption coefficients in unassociated liquids has generally been ascribed to relaxation phenomena in energy distribution among the internal degrees of freedom of the molecules.

Recently, J. M. M. Pinkerton[1] and E. Bauer[2] have presented theoretical interpretations of the absorption in a system (benzene – toluene) of two unassociated liquids with very different absorption coefficients. Their treatment assumes a behaviour strictly analogous to that of pure gases containing impurities. According to this interpretation, addition to an unassociated liquid of molecules of another liquid leads to a quicker attainment of the energy distribution and hence decreases absorption.

We have studied mixtures composed of an unassociated liquid having large absorption and an associated liquid having much smaller absorption and low viscosity. In these associated liquids the origin of relaxation phenomena seems to be in the distortion of their structure produced by acoustic waves.



In the accompanying graph, the values of the parameter α/f^2 (α is amplitude absorption coefficient ; f is frequency) for the systems benzene – ethyl alcohol, carbon tetrachloride – ethyl alcohol, carbon tetrachloride – methyl alcohol are given, measurements having been carried out by an optical method[3], at 8 Mc./s.

The curves are similar in every way to that for the system benzene – toluene. It is clear, therefore, that in the mixtures examined the variation of the absorption with concentration is chiefly due to the decrease of absorption in the unassociated component, which has a large coefficient, on account of the presence of different molecules, just as if the second component were also an unassociated liquid.

D. SETTE

Istituto Naz. Ultracustica,
Rome.
Feb. 2.

[1] Pinkerton, J. M. M., *Proc. Phys. Soc.*, B, **62**, 129 (1949).
[2] Bauer, E., *Proc. Phys. Soc.*, B, **62**, 141 (1949).
[3] Sette, D., *Nuovo Cim.*, **7**, No. 1 (1950).

Anharmonicity of the Lattice Oscillations in the Alkali Halide Crystals

THE oscillations of the two interpenetrating lattices of the alkali and the halide ions respectively, in alkali halide crystals, with respect to each other, have been studied in detail, particularly in relation to the infra-red and the Raman spectra of the crystals, and the contribution of the electric dipole moments associated with these oscillations to the dielectric constants of the crystals. These oscillations are presumed to be anharmonic—the anharmonicity being attributed sometimes to the size of the amplitude of the oscillations—and the anharmonicity is invoked to explain the occurrence of certain combination frequencies in Raman spectra, and the temperature variation of the specific heat at constant volume at high temperatures. No attempt, however, seems to have been made to estimate the magnitude of the anharmonicity, though it can be done readily on the basis of any simple model of the crystal, as, for example, Born's, which regards the lattices of the positive and the negative ions respectively as held together by electrostatic forces between the ions, and by Van der Waals forces of repulsion between them, which die down much more rapidly with distance than the electrostatic forces. (The inclusion of forces due to the polarizabilities of the ions does not appreciably affect the results.)

Let us consider a halide of the NaCl type. Neglecting Van der Waals repulsions except between nearest neighbours, and taking the repulsion potential between two neighbouring ions to be $A\exp(-R/\rho)$, where R is the distance between them, we obtain, for the potential energy of the crystal per ion,

$$U = \tfrac{1}{2}\{-\alpha e^2/R + 6A\exp(-R/\rho)\}, \qquad (1)$$

in which $\alpha = 1{\cdot}748$ is the Madelung constant. Now using the equilibrium condition $(\partial U/\partial R)_{R=d} = 0$, where d is the distance between the sodium and chloride ions, we may eliminate A in the usual manner, and with the help of the relation $(\partial^2 U/\partial R^2)_{R=d} = 9d/\beta$, where β is the isothermal compressibility, determine ρ. We thus find that, in sodium chloride, d/ρ, which we shall denote by δ, is about 9.

Now taking the cubic axes of the crystal as the xyz axes of a co-ordinate system, and separating the Na^+ and the Cl^- lattices from each other by a small distance r in the direction lmn, we obtain for the potential energy of the deformed crystal per ion the expression

$$U = U_0 + ar^2 + br^4 + cr^4(l^4 + m^4 + n^4), \qquad (2)$$

in which

$$U_0 = -\frac{e^2\alpha}{2d}\left(1 - \frac{1}{\delta}\right) = -6{\cdot}4 \times 10^{-12}$$

$$a = \frac{e^2}{d^3}\alpha\frac{(\delta - 2)}{12} = 1{\cdot}05 \times 10^{4} \qquad (3)$$

$$b = \frac{e^2}{d^5}\left\{\frac{21}{8} - \frac{7}{27\sqrt{3}} - \alpha\frac{(2^{\circ 2} + 3\delta + 3)}{48}\right\} = -0{\cdot}59 \times 10^{20}$$

$$c = \frac{e^2}{d^5}\left\{-\frac{35}{8} + \frac{35}{81\sqrt{3}} + \alpha\frac{(\delta^2 + 6\delta^2 + 15\delta + 15)}{144}\right\} = 1{\cdot}62 \times 10^{20}.$$

In the expressions for a, b and c, the terms involving α arise from Van der Waals repulsion, and the other terms in them from electrostatic interaction. In the numerical values, which refer to sodium chloride, the energies are expressed in ergs, and r in cm.

It will be seen that the r^2 term, which determines the frequency ν_0 of the oscillations of the two lattices with respect to each other, arises wholly from Van der Waals repulsion, the electrostatic forces contributing nothing to it, and that it is independent of the direction of the oscillations. Equating its coefficient to $2\pi^2\mu\nu_0^2$, where $1/\mu = 1/m_1 + 1/m_2$ and m_1 and m_2 are the masses of sodium and chloride ions respectively, one obtains $\nu_0 = 4{\cdot}8 \times 10^{12}$, which is of the right magnitude.

The coefficient of r^4, which we shall denote by f, determines the anharmonicity of the oscillation. It will be seen that both the electrostatic and the Van der Waals interactions contribute to f, and further, that f varies with the direction of the oscillation, and is a maximum, equal to $b + c$—positive and large—when the oscillation is along any of the cubic axes, and is a minimum, equal to $b + c/3$—negative and numerically small—when the oscillation is along any of the octahedral directions [111].

The energy of the oscillator is given by[1]

$$W = (n+\tfrac{1}{2})\,h\nu_0 + \frac{3}{64\pi^4}(2n^2+2n+1)\,\frac{h^2 f}{\mu^2\nu_0^2}. \qquad (4)$$

When the oscillation is along [100], the anharmonicity will correspond to the frequency of the octave being 1·1 per cent greater than twice that of the fundamental.

The anharmonicities of other modes of oscillation of this crystal, and of the oscillations of the other alkali halides, may be calculated in the same manner.

The specific heat of the crystal at constant volume at high temperatures due to any such *linear* oscillation will be given by[2]

$$c_v = k\left(1 - \frac{3fkT}{8\pi^4\mu^2\nu_0^4}\right) \qquad (5)$$

For Na versus Cl oscillation along [100], expression (5) corresponds to a fall in the value of c_v of about 1 per cent per 50° C., and for oscillation along [111] to practically no temperature variation. Some rough estimates of c_v of sodium chloride crystal made by Eucken and Dannohl[3] on the basis of extrapolated values for the compressibility at high temperatures do point to a fall in c_v, and of this order of magnitude, which suggests that any observed fall in c_v at high temperatures may be attributed to the anharmonicity of the thermal oscillations.

K. S. Krishnan
National Physical Laboratory of India,
New Delhi.
April 26.

[1] See, for example, Pauling and Wilson, "Introduction to Quantum Mechanics", 161 (McGraw-Hill, 1935).
[2] See Born and Mayer, "Handbuch der Physik", 24/2, 676 (Julius Springer, 1933).
[3] *Z. Elektrochem.*, **40**, 814 (1934).

Modification of a Fingerprint by a Skin Graft

It would appear that the case reported by Sir Francis Galton[1] is unique and, therefore, the present similar case has interest.

Galton's subject, a solicitor aged twenty-five, sliced off a portion of his left thumb when cutting some cardboard; the soft part of the digit, when pressed upon a ruler to steady the cardboard, had bulged into the path of the knife. He picked up the severed portion and applied it to his thumb, which was then tightly bandaged. The graft was successful; but, as the rolled impression, taken thirty years later, shows, it had been applied at right angles to its original position. In consequence, there remained a corresponding deviation of the skin ridges.

The present subject, when aged thirty-two in 1912, was slicing some fruit in a machine, which operated a circular knife. By mischance she sliced off a portion of the outer side of the tip of her left forefinger. She promptly recovered the piece from the blade of the machine and carefully replaced it, "matching the finger grain" on her finger. A bandage moistened with 'Friar's Balsam' was applied and retained in position for some weeks, during which time she kept it moist with the tincture. It is a source of distinct satisfaction to her that, despite a medical practitioner's gloomy prognosis, the graft was successful. Some months elapsed before full sensation returned to the area, but to-day it is normal. Unlike Galton's subject, she had indeed matched the grain of her finger; but, in spite of her care, there remains evidence of local distortion of the pattern of the finger-skin, due to healing of the graft. This is shown in the present rolled impression, prepared in January 1950, thirty-seven years after her accident. It is unlikely that even skilled surgery would leave less trace than this.

Since the subject lives at a distance, the print was obtained by the method used by Looms and Campbell[2]. She was supplied with an ordinary office ink pad, some sheets of paper and instructions in their use. The present impression was one of several which she herself made at her own home, without any prior experience.

I am grateful to 'A. D. S.' for her interest and co-operation and for permission to publish this note.

Cyril John Polson
Department of Forensic Medicine,
School of Medicine, Leeds 2.
March 20.

[1] *Nature*, **53**, 295 (1896).
[2] "The Murder of June Anne Devaney", p. 48 (Central Police Office, Blackburn, 1949).

'Weber's Glands' and Respiration in Woodlice

The view has long been held that certain tegumental glands in woodlice, known as 'Weber's glands', play an important part in respiration, and have been evolved in adaptation to terrestrial life. This conception appears to be wholly mistaken. It seems to have originated in a misreading of the literature, and although widely accepted there is little evidence of any real attempt to confirm it by direct observation.

A brief description of the several varieties of tegumental gland in terrestrial Isopods and a detailed account of the rosette glands have already been given[1]. The largest and most interesting glands are the lobed forms, which may be induced by appropriate stimulation to pour their fluid secretions on to the surface of the body. Herold[2] distinguished between three types of lobed gland opening respectively on the lateral plates, on the uropods, and at the bases of the pleopods or gills. This third group he named 'Weber's glands'. Among the scattered literature on the subject, one point of general agreement stands out—the belief that 'Weber's glands' secrete a fluid which moistens the gills. This conception has crept into almost every paper, review and text-book dealing with the subject of respiration or tegumental glands in woodlice published during the past half-century. It is rather surprising, therefore, to discover that 'Weber's glands' do not, in fact, exist, either in the animal or in the publications of their supposed discoverer, Weber.

Examination of sections of several genera of terrestrial Isopods has failed completely to reveal any lobed glands other than those opening on the lateral plates and uropods, or glands of any sort opening at the bases of the gills. Furthermore, a careful scrutiny of the relevant paper by Weber[3] proves conclusively that, although incorrect in certain details, Weber's descriptions and figures of tegumental glands refer solely to those of the lateral plates and uropods.

The 'Weber's gland' myth, elaborated by Herold in 1913, may be traced back to Bepler's "inaugural-dissertation" on respiration in woodlice published in 1909[4], in which the glands described by Weber have been confused with certain structures in the abdomen described (also incorrectly) by Němec in 1895–96[5,6]. Bepler's only reference to Němec's work is to a brief unillustrated preliminary notice[7]. Had he compared the descriptions and excellent figures in Němec's full accounts[5,6] with those of Weber[3] he could not have failed to realize that the two authors were dealing with entirely different and totally unrelated structures. It was to the organs compounded by Bepler from these unrelated structures that Herold gave the name of 'Weber's glands'.

Weber, who examined only teased and cleared material, wrongly assumed that the glands are confined to the hinder (gill-bearing) part of the body, and that they open on the *under* side of the plates and uropods. This led him to suggest that their secretion bathes the whole ventral surface of the abdomen and serves to form a protective layer, insoluble in water, over the gills. In fact, lobed glands occur in all free thoracic and abdominal segments, and their ducts invariably open on the *upper* (dorsal) surface of the lateral plates, and on the *outer* edge of the uropods. Although the lateral plate and uropod glands form secretions which differ in several respects, considerable experimental evidence shows that in both cases the secretion is liberated only after violent stimulation (mechanical, chemical, thermal, electrical, etc.), never spreads from the duct openings, is soluble in water but rapidly solidifies in air. The fluid which bathes the gill endopodites is clearly not derived from the lobed glands.

It seems equally improbable that it is secreted by Němec's organs (confused by Bepler with the lobed glands). These have the form of winding branching canals lying in the large ventral abdominal blood space and penetrating into the bases of the gills. Němec considered them to be excretory, and stated that they open on to the body surface at the bases of the gills. His accurate figures, however, show the canals coming very close to the body-wall but not actually penetrating it. They do not, in fact, appear to open to the surface at all, and there is evidence in favour of the view first suggested by Kimus[8] and supported by Unwin[9] that they form a spongy tissue ("*tissu intermediaire*" of Kimus) which serves to control the speed and direction of the blood-flow through the gills.

There appear to be two possible alternative sources of gill fluid, neither of which postulates the existence of special glands. First, part of the gill fluid may well be derived from the blood by simple diffusion of certain constituents through the gill membrane, as in a vertebrate lung or an insect tracheole[10]. Both blood and gill fluid have a strongly alkaline reaction (*p*H greater than 8·0), whereas the uropod secretion is almost neutral (*p*H about 7·4) and the lateral plate secretion strongly acid (*p*H about 2·4). Secondly, Verhoeff[11] has demonstrated the presence of an elaborate capillary water-conducting system in woodlice by which water on any part of the body is rapidly transferred to the gills. Although woodlice normally appear to have little opportunity for access to liquid water, they may perhaps during nocturnal activity make use of dew, obtained not only by contact with water droplets on surrounding objects but also conceivably by direct condensation on their own bodies.

It is clear, therefore, that the lobed glands do not contribute to the formation of the gill fluid, and they do not appear, as was formerly supposed[1], to secrete a protective layer over the general body surface. While positive evidence is somewhat elusive, extensive experimental work has led to the conclusion that they almost certainly function as defence glands.

Details of the characters of these and other tegumental glands, and a fuller analysis of the evidence concerning their functions, will be given elsewhere.

H. Gorvett

Department of Zoology and Applied Entomology,
Imperial College of Science and Technology,
London, S.W.7.

March 17.

[1] Gorvett, H., *Quart. J. Micr. Sci.*, **87**, 209 (1946).
[2] Herold, W., *Zool. Jahrb. Jena (Anat.)*, **35**, 457 (1913).
[3] Weber, M., *Arch. Mikr. Anat.*, **19**, 579 (1881).
[4] Bepler, H., "Über die Atmung der Oniscoideen" (Greifswald, 1909).
[5] Němec, B., *Sb. Böhm. Ges. Wiss., nat.-math. Kl.*, 45 (1895).
[6] Němec, B., *Sb. Böhm. Ges. Wiss., nat.-math. Kl.*, 25 (1896).
[7] Němec, B., *Zool. Anz. Leipzig*, **19**, 297 (1896).
[8] Kimus, J., *Cellule*, **15**, 297 (1897).
[9] Unwin, E. E., *Pap. Roy. Soc. Tasm.*, 37 (1932).
[10] Wigglesworth, V. B., "The Principles of Insect Physiology" (London, 1947).
[11] Verhoeff, K. W., *Z. wiss. Zool., Leipzig*, **113**, 365 (1919).

Identity of a Muscle-inhibiting Flavone in Lucerne

It was suggested in an earlier note[1] that the flavone isolated from lucerne which, like most flavones, inhibits smooth-muscle movements, was 3′,4′,5-trihydroxy-7-methoxyflavone. Further work on larger quantities of the flavone purified by high-vacuum sublimation has now shown it to be tricin, 5,7,4′-trihydroxy-3′,5′-dimethoxyflavone, a flavone found in *Triticum dicoccum*[2].

Its constitution was finally settled by comparing its elementary analysis, methoxyl content, R_F value and ultra-violet absorption with those of authentic

tricin. Analytical data on the methylated and acetylated compounds, and mixed melting points, gave further confirmation.

It cannot be assumed that tricin is the only flavone occurring in lucerne, and we have noted certain lucerne flavone preparations possessing greater activity on smooth-muscle movements than the purified isolated tricin.

We wish to acknowledge with thanks a gift of tricin from Dr. J. A. Anderson, of Winnipeg.

W. S. Ferguson
de B. Ashworth
R. A. Terry

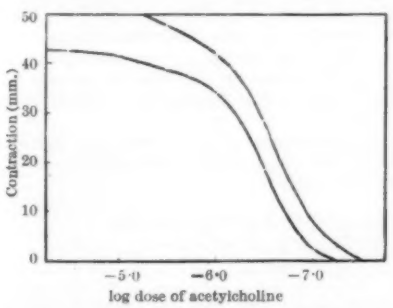
Imperial Chemical Industries, Ltd.,
Jealott's Hill Research Station,
Bracknell, Berks.
March 28.

[1] Ferguson, W. S., Ashworth, de B., and Terry, R. A., *Nature*, **163**, 606 (1949).
[2] Anderson, J. A., *Can. J. Res.*, **9**, 80 (1933).

Statistical Planning in Experiments on the Isolated Rat Uterus

The use of statistical methods for obtaining estimates of error in biological assays was demonstrated by Schild[1] in a paper on the assay of histamine using guinea pig gut as test object. In 1943, Beauvillain[2] used the rat uterus for assays of oxytocic activity in pituitary preparations, and recently Holton[3] has applied Schild's methods to assays of posterior pituitary extract using the same preparation. Holton has shown that assays on the isolated rat uterus may be made more rapidly than on the isolated guinea pig uterus as prescribed in the British Pharmacopœia[4], and the accuracy of her assays was greater.

In order to study the use of the rat uterus for assay purposes, tests were made using acetylcholine solutions as standards for reference. It was found that the cycle of contraction and relaxation was rapid in comparison with that for the guinea pig. The use of statistical planning was then invoked in order to determine the relationship between the dose of acetylcholine and the contraction produced. Using the balanced experimental design known as the Latin Square, it was found convenient to obtain up to ten contractions to each of the same number of doses, the experiment lasting between three and five hours. If the mean contraction to each dose is then plotted against the logarithm of the concentration of acetylcholine, a smooth dose-response curve is obtained.



Experiment 35: dose response curves for acetylcholine in the case of the rat uterus, using the 8 × 8 Latin Square; recorded on the two horns of the same preparation

The advantage of the use of this design is in the minimization of the effects of variations in sensitivity of the preparation. The accompanying graph shows the type of curve obtained.

The experimental technique has been extended to the recording of curves showing the inhibitory action of histamine and some antihistamines and other substances on the responses of the rat uterus to acetylcholine. Details of these experiments will be published in due course. It is a pleasure to acknowledge the assistance of Mr. K. N. Chandler, of the Mathematics Department of this University, in their design.

J. G. Fletcher

Pharmacology Laboratories,
Pharmacy Department,
University of Nottingham.
Jan. 12.

[1] Schild, H. O., *J. Physiol.*, **101**, 115 (1942).
[2] Beauvillain, A., *C.R. Soc. Biol., Paris*, **137**, 284 (1943).
[3] Holton, P., *Brit. J. Pharmacol.*, **3**, 328 (1948).
[4] "British Pharmacopœia", 813 (London: Constable, 1948).

The Soil-Plate Method for Isolation of Fungi from Soil

Research on the ecological distribution of fungi in soil, in progress in this laboratory, has been facilitated by the use of a simple plating technique, whereby soil is distributed throughout a thin layer of nutrient medium. A soil plate is prepared by transferring a small amount of the soil to be examined into a sterilized Petri dish. 8–10 ml. of cooled medium is added and the soil particles dispersed throughout the agar. With sandy soils an adequate dispersal may be obtained by shaking and rotating the plate before the agar solidifies. If, however, the soil is very dry, or contains a high proportion of clay, it is preferable to mix the particles with a drop of sterile water in the plate, before the medium is added. The amount of soil used in the preparation of a soil plate varies with the soil investigated, and is determined by trial. With many natural surface soils about 0·005–0·015 gm. of soil has been found to give a convenient number of colonies on each plate. Czapek–Dox + 0·5 per cent yeast extract agar, acidified with phosphoric acid to *p*H 4·0, has been found a satisfactory medium for the growth and sporulation of many soil fungi and has been extensively used as an isolation medium. A microspatula made by flattening the end of a nichrome needle has been found useful for transferring soil and crushing soil aggregates.

Trials have shown that soil plates are easier to prepare and have several advantages over isolation plates prepared by either the direct method[1] or from soil dilutions. The direct method has been found unsatisfactory because a film of water soon surrounds soil particles placed on agar and favours excessive growth of bacteria even on acid media. Dilution methods, although widely used, are very laborious and are also selective with respect to species and groups of soil fungi isolated. Comparisons have been made of the numbers of species of fungi isolated from soil samples by soil plate and by dilution methods. The accompanying table records the numbers of species obtained from two different soils. Ten plates were prepared by each method; in the dilution method, isolation plates were prepared both from the soil suspension and from the residue of heavy soil particles left at the bottom of the container.

COMPARISON OF THE NUMBERS OF SPECIES ISOLATED BY DILUTION AND SOIL-PLATE METHODS

	Soil plate	Dilution suspension	Dilution residue
Soil *E*			
Av. no. of species per plate	10·5	9·5	9·5
Total no. of species per sample	22	16	21
Soil *C*			
Av. no. of species per plate	15	10	15
Total no. of species per sample	24	21	24

It is interesting to note that both soil plates, and isolation plates made from the residue after preparation of the soil suspension, gave a higher number of species than isolation plates poured from the suspension. It would seem that shaking soil with water does not allow all the fungi present to pass into suspension, and that isolation plates which incorporate soil particles are likely to yield a wider range of species than dilution plates.

By the use of this method a wide range of fungi has been isolated from soil, including genera such as *Pythium*, *Mortierella* and many of the darker-coloured Hyphomycetes, which are not usually recorded from soil[2]. Other interesting organisms such as *Dictyostelium mucoroides* and Myxomycete plasmodia have been found on soil plates. Several Basidiomycetes, particularly 'fairy ring fungi' such as *Marasmius oreades*, *Tricholoma nudum* and *Psalliota arvensis*, which have a definite mycelial zone in the soil, have been isolated from soil by this method.

A detailed account of this work will be published elsewhere.

I am much indebted to Prof. F. T. Brooks for his interest in this work.

J. H. WARCUP

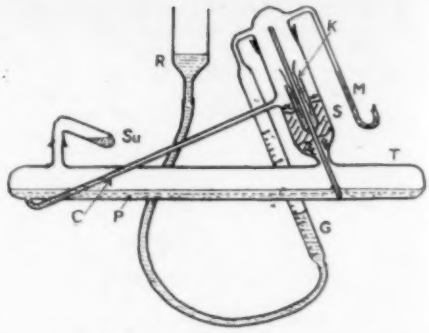
Botany School,
Cambridge.
March 8.

[1] Waksman, S. A., *Science*, N.S., **44**, 320 (1916).
[2] Chesters, C. G. C., *Trans. Brit. Mycol. Soc.*, **32**, 197 (1949).

A Percolating Respirometer

THE soil percolation technique[1] was introduced for the study of soil metabolism. In this technique small volumes of a water solution of metabolites are taken regularly and frequently from a reservoir, allowed to percolate through a column of aerated soil, and returned to the reservoir. The course of soil metabolism is then followed by analyses of the reservoir fluid. The original apparatus[2] has since been modified[3] and adapted to the measurement of the carbon dioxide outputs of percolated soils[4]. The apparatus to be described permits the measurement of the oxygen uptakes of percolated soils or indeed of any metabolizing system capable of being supported on a solid porous medium.

The design of the apparatus is shown in the diagram. It consists of two halves, the second of which (not shown) is essentially a compensating vessel for the first and is connected to the other side of manometer *M*. This compensating vessel is similar to its companion in all respects except that it has only one side arm and does not carry a graduated pipette *G*. The oxygen uptake of the soil in the first vessel is followed by the Haldane technique already used for static experiments with soils[4]. As the soil *S* consumes oxygen it evolves carbon dioxide, which is absorbed by the caustic potash solution in the cup *K*. This cup is removable and has the usual slip of filter paper



inserted into it to facilitate absorption of carbon dioxide. Oxygen uptake in the first vessel is measured directly from the readings of the water-levels in the graduated pipette *G*, taken when the water reservoir *R* has been raised to a point at which the levels of liquid in the two arms of manometer *M* are equal.

The whole apparatus is mounted on a rocking platform with the soil tubes in a vertical plane. To make the percolate *P* run through the soil *S* (which is held in position between glasswool plugs), the platform is tipped clockwise in a vertical plane. The small amount of percolate that has collected in the bend of tube *C* then runs down *C* on to the soil, forcing the air in *C* before it and through the soil, while the bulk of the percolate runs back to the other end of the main tube *T*. If the apparatus is kept gently rocking between two positions, in one of which *T* is horizontal as shown in the diagram, and in the other of which *T* is tipped clockwise some 60° to the horizontal, continual and satisfactory percolation and aeration of the soil is achieved.

The side arm *Su* contains a solution of substrate, for example, glucose solution. In the position shown for *Su*, the substrate solution remains apart from the bulk of the percolate even when the apparatus is rocked. The substrate may be added to the percolate without opening or disturbing the apparatus in any way merely by rotating *Su* through 180° on its ground-glass joint, when the substrate solution will automatically run into *T* as *T* tips clockwise. The tube *Su* is conveniently removable when the percolate is to be sampled.

Preliminary experiments, in which the excess oxygen uptake due to the percolation of 5 mgm. glucose in 50 ml. solution through 10 gm. lots of soil has been measured, have given results that indicate that this uptake is about two-thirds of what is required by theory for the complete conversion of glucose to carbon dioxide. These results are in agreement with those obtained on glucose-percolated tropical soils[5], which were found to release, as carbon dioxide, some two-thirds of the carbon percolated as glucose.

Full constructional details of the apparatus, and a description of the results obtained with it, will appear elsewhere.

HOWARD LEES

Department of Biological Chemistry,
University, Aberdeen.
March 20.

[1] Lees, H., *Plant and Soil*, **1**, 221 (1949).
[2] Lees, H., and Quastel, J. H., *Chem. and Indust.*, No. 26, 238 (1944).
[3] Lees, H., *J. Agric. Sci.*, **37**, 27 (1947).
[4] Lees, H., *Plant and Soil*, **2**, 123 (1949).
[5] Lees, H., and Porteous, J. W., *Plant and Soil*, **2**, 231 (1950).

FORTHCOMING EVENTS

Tuesday, July 18—Thursday, July 20

SOCIETY OF DAIRY TECHNOLOGY (at the Royal Agricultural College, Cirencester).—Summer Meeting.

Friday, July 21

BIOCHEMICAL SOCIETY (in the Department of Biochemistry, University New Buildings, Teviot Place, Edinburgh), at 11 a.m.—Scientific Papers.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

STATISTICIAN (with good honours degree) to assist in the application of statistical methods to the problems of fruit experimentation, both in the field and in the laboratory—The Secretary, East Malling Research Station, Maidstone, Kent (July 21).

ASSISTANT LECTURER IN THE AGRICULTURAL CHEMISTRY DEPARTMENT—The Registrar, University College of Wales, Aberystwyth (July 22).

ASSISTANT LECTURER IN ANATOMY—The Registrar, The University, Manchester 13 (July 22).

ASSISTANT PHYSICIST (with an honours degree in physics) in the Radiotherapeutic Department—The Clerk to the Governors, St. Bartholomew's Hospital, London, E.C.1, endorsed 'Physicist' (July 22).

HEAD OF THE SCIENCE AND METALLURGY DEPARTMENT of Constantine Technical College—The Director of Education, Education Offices, Middlesbrough (July 22).

LECTURER (with a good degree in chemistry and, preferably, teaching and/or industrial experience) IN THE DEPARTMENT OF CHEMISTRY, Leeds College of Technology—The Chief Education Officer, Education Offices, Leeds 1 (July 22).

LECTURER IN THE ENGINEERING DEPARTMENT, County Technical College, Wednesbury—The Director of Education (Dept. F.E.), County Education Offices, Stafford (July 22).

SENIOR SCIENTIFIC OFFICER (with an honours degree in botany or agricultural botany or its equivalent and a sound knowledge of the principles of genetics and practical plant breeding) in the Plant Breeding Division of the Ministry of Agriculture—The Secretary, Civil Service Commission, Stormont, Belfast (July 25).

ASSISTANT MASTER to teach science subjects to School Certificate standard, at Markham College, Lima, Peru—The Director, Personnel Department, British Council, 65 Davies Street, London, W.1 (July 26).

HUMAN PHYSIOLOGIST at the Royal Air Force Institute of Aviation Medicine, South Farnborough, Hants, to organize and conduct physiological research into the basic reactions of human subjects, etc.—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1, quoting No. 3173 (July 27).

CIVIL ENGINEER in the Chief Engineer's Department at London headquarters—The Secretary's Office (Establishments), Applications Section, British Electricity Authority, British Electricity House, Great Portland Street, London, W.1, endorsed Ref. AE.75 (July 28).

LECTURER IN ENGINEERING (Mechanical)—The Registrar, University College, Cathays Park, Cardiff (July 28).

PRINCIPAL LECTURER or SENIOR LECTURER IN STRUCTURES (unestablished), a SENIOR LECTURER IN either MATHEMATICS, MACHINES, MECHANICS, MATERIALS, or STRUCTURAL DESIGN (established), a SENIOR LECTURER IN HEAT ENGINES (unestablished), a SENIOR LECTURER or LECTURER IN ELECTRICAL ENGINEERING (unestablished), and a LECTURER IN either MATHEMATICS, BALLISTICS, PHYSICS, CHEMISTRY, MECHANICS, or ELECTRICAL ENGINEERING (established), at the Military College of Science, Shrivenham, Wilts—The Secretary, Civil Service Commission, 7th Floor, Trinidad House, Old Burlington Street, London, W.1, quoting No. 3157 (July 28).

SENIOR SCIENTIFIC OFFICER at the Ministry of Agriculture and Fisheries Laboratory, Conway, North Wales—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. 3162 (July 28).

ASSISTANT LECTURERS IN METALLURGY (with qualifications in either metallurgy, chemistry, physics, or strength of materials)—The Registrar, The University, Manchester 3 (July 31).

RESEARCH ASSISTANT IN THE DEPARTMENT OF CHEMISTRY, University College, Dundee, to undertake work on the thermodynamics of solutions—The Secretary, The University, St. Andrews (July 31).

VETERINARY OFFICERS and RESEARCH OFFICERS in the Ministry of Agriculture and Fisheries—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 3155 (August 3).

SENIOR RESEARCH OFFICER (Chemist), at the Irrigation Research Station, Griffith, N.S.W., to conduct research into various chemical aspects of plant growth and soil problems on the Murrumbidgee Irrigation Area—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 2724 (August 5).

PSYCHOLOGISTS, SENIOR PSYCHOLOGISTS, PRINCIPAL PSYCHOLOGISTS, and SENIOR PRINCIPAL PSYCHOLOGISTS, in the Admiralty, Air Ministry, Civil Service Commission and Prison Commission—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 3075 (August 10).

LECTURESHIPS in the Faculty of Veterinary Science, University of Queensland, to be chosen from fields including bacteriology, pathology, surgery, medicine, parasitology, veterinary physiology, veterinary anatomy, and zootechny (genetics)—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (August 15).

CHAIR OF SURVEYING AND PHOTOGRAMMETRY at University College—The Academic Registrar, University of London, Senate House, London, W.C.1 (August 30).

LECTURER IN THE DEPARTMENT OF MATHEMATICS (with qualifications in pure mathematics, applied mathematics or statistics), University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (August 31).

ASSISTANT LECTURERS (2) IN ORGANIC CHEMISTRY—The Head of the Department of Organic Chemistry, Imperial College of Science and Technology, South Kensington, London, S.W.7 (September 1).

CHAIR OF PURE MATHEMATICS—The Secretary, Queen's University, Belfast (November 15).

ABSTRACTOR (male or female, with degree in engineering or physics or equivalent qualification, and a knowledge of German or Dutch), mainly for abstracting and summarizing technical and scientific papers in shipbuilding, marine engineering, naval architecture, etc.—The Secretary, British Shipbuilding Research Association, 5 Chesterfield Gardens, London, W.1.

APPLIED MATHEMATICIANS in the Technical Section: (*a*) Senior Mathematician to direct a small mathematical sub-section undertaking varied, and to some extent unpredictable, work, including the study of economical employment of novel processes, stability of complex plant operation, problems in air and gas dynamics, heat conduction and transfer, etc., and (*b*) a Mathematician to assist with this work—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

ASSISTANT LECTURER IN PHYSICS in the Department of Natural Philosophy—The Secretary, Royal Technical College, Glasgow.

CHEMIST with interests in Biology, to develop histochemical technique with particular emphasis on enzyme studies—The Morbid Anatomist, Hospital for Sick Children, Great Ormond Street, London, W.C.1.

CHIEF METALLURGIST to take charge of the metallurgical development work, and to give advice to the designers and operators of atomic energy factories, and a DEPUTY CHIEF METALLURGIST to take control of the laboratories—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

ELIZABETH MACADAM FELLOWSHIPS for research into the aetiology and pathogenesis of osteo-arthritis and/or the aetiology and pathogenesis of spondylitis ankylopoietica—The General Secretary, Empire Rheumatism Council, Tavistock House (N), Tavistock Square, London, W.C.1.

ENGINEER to undertake development work in connexion with novel applications of pumps, compressors and turbo-machinery generally, and inspection of installations—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

GRADUATE (with a knowledge of chemistry or physics up to degree standard and a good knowledge of French and/or German) for abstracting and summarizing technical papers and work connected with the preparation and distribution of the Association's publications—The Director of Research, British Leather Manufacturers' Research Association, Milton Park, Egham, Surrey.

INDUSTRIAL RESEARCH CHEMIST to take charge of the Applied Research Laboratories in the Division of Atomic Energy (Production), at Seascale, Cumberland—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

JUNIOR PHYSICISTS (6) for fundamental research work—electrical, frictional, dynamic properties of rayon, air propulsion, etc.—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, Manchester.

JUNIOR PHYSICISTS or ELECTRICAL ENGINEERS (graduates) in the Electronics and Electrical Departments—The British Scientific Instruments Research Association, 'Sira', Southill, Elmstead Woods, Chislehurst, Kent.

JUNIOR RESEARCH PHYSICIST for investigations on the physical properties of leather—The Director of Research, British Leather Manufacturers' Research Association, Milton Park, Egham, Surrey.

LECTURER IN CHEMISTRY—The Principal, County Technical College, Kingston Hall Road, Kingston, Surrey.

LECTURER IN THE DEPARTMENT OF MATHEMATICS—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1.

PLANNING ENGINEERS to undertake the construction planning of large factories and the planning of plant and equipment installations, designed for mechanical and chemical processes—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

RESEARCH ASSISTANT IN ENTOMOLOGY—Prof. A. D. Peacock, University College, Dundee.

RESEARCH FELLOWSHIP for research into problems connected with heating and ventilating—The Secretary, Institution of Heating and Ventilating Engineers, 75 Eaton Place, London, S.W.1.

RESEARCH OFFICER in the East African Agriculture and Forestry Research Organisation, to undertake independent work on the genetics and breeding of crop plants, including groundnuts and maize, and to collaborate with plant pathologists in the breeding of disease resistant types—The Under-Secretary of State, Colonial Office, Research Department, Sanctuary Buildings, Great Smith Street, London, S.W.1.

SCIENTIFIC ASSISTANT (with a science degree and a knowledge of foreign languages, preferably Spanish and Portuguese), mainly for examining and abstracting scientific literature on grassland and field crop research—The Commonwealth Bureau of Pastures and Field Crops, Penglais, Aberystwyth.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Department of Agriculture for Scotland. Miscellaneous Publication No. 17: The Biology and Control of the Ant Pest, *Monomorium pharaonis* (L.). By Prof. A. D. Peacock, D. W. Hall, I. C. Smith and A. Goodfellow. Pp. 51. (Edinburgh and London: H.M. Stationery Office, 1950.) 1*s.* net. [95

Philosophical Transactions of the Royal Society of London, Series A: Mathematical and Physical Sciences. No. 848, Vol. 242: Diophantine Inequalities with an Infinity of Solutions. By H. Davenport and C. A. Rogers. Pp. 311–344. 7*s.* 6*d.* No. 849, Vol. 242: The

Numerical Solution of Elliptic Differential Equations when the Boundary Conditions involve a Derivative. By L. Fox. Pp. 345–378. 7s. 6d. (London: Cambridge University Press, 1950.) [95

British Standard 506 : 1950, Methyl Alcohol (Methanol). Pp. 12. 2s. net. British Standard 507 : 1950, Ethyl Alcohol (Ethanol). Pp. 8. 2s. net. British Standard 508 : 1950, Normal Butyl Alcohol (Butanol). Pp. 8. 2s. net. British Standard 509 : 1950, Acetone. Pp. 9. 2s. net. British Standard 549 : 1950, Diacetone Alcohol. Pp. 8. 2s. net. British Standard 551 : 1950, Normal Butyl Acetate. Pp. 8. 2s. net. British Standard 552 : 1950, Amyl Acetate. Pp. 8. 2s. net. British Standard 553 : 1950, Ethyl Acetate. Pp. 8. 2s. net. British Standard 572 : 1950, Interchangeable Conical Ground Glass Joints. Pp. 12. 2s. net. British Standard 573 : 1950, Dibutyl Phthalate. Pp. 7. 2s. net. British Standard 574 : 1950, Diethyl Phthalate. Pp. 7. 2s. net. British Standard 575 : 1950, Carbon Tetrachloride. Pp. 9. 2s. net. British Standard 576 : 1950, Acetic Acid. Pp. 21. 2s. 6d. net. British Standard 580 : 1950, Trichlorethylene (Types A, B and C). Pp. 13. 2s. net. British Standard 662 : 1950, Carbon Disulphide. Pp. 9. 2s. net. British Standard 663 : 1950, Ethyl Lactate. Pp. 9. 2s. net. British Standard 1593 : 1950, Perchlorethylene. Pp. 8. 2s. net. British Standard 1594 : 1950, Diacetin (Glyceryl Diacetate). Pp. 8. 2s. net. British Standard 1595 : 1950, Isopropyl Alcohol (Isopropanol). Pp. 8. 2s. net. (London: British Standards Institution, 1950.) [95

Atomic Attack: Can Britain be Defended? Pp. vii+22. (London: Association of Scientific Workers, 1950.) 1s. [115

Department of Scientific and Industrial Research: Road Research Laboratory. Road Research Technical Paper No. 17: The Compaction of Soil; a Study of the Performance of Plant. By F. H. P. Williams and D. J. Maclean. Pp. vi+46+8 plates. (London: H.M. Stationery Office, 1950.) 1s. 6d. net. [115

Annual Report of the Oundle School Natural History Society for the 1949 Season. Pp. 26. (Oundle: Oundle School, 1950.) 2s. [115

British Institute of Management. Personnel Management Series, 3: Wage Incentive Schemes. Pp. 26. (London: British Institute of Management, 1950.) 2s. 6d. [155

Organizing for Output. Pp. 66. (London: British Institute of Management, 1950.) 2s. 6d. [155

Report of the Proceedings of the 1949 Conference of the Universities of Great Britain and Northern Ireland. Pp. 101. (London: Association of Universities of the British Commonwealth, 1950.) 1s. [155

Royal Institute of Chemistry. Lectures, Monographs and Reports, 1950, No. 1: Report of a Symposium on the Hydrogen Bond, 25 March 1949. Pp. 31. (London: Royal Institute of Chemistry, 1950.) 3s. net. [155

A Summary of the Proceedings at the Conference on Foundry Steel Melting held at Ashorne Hill, Leamington Spa, September 22 and 23, 1949. Pp. 73. (London: British Iron and Steel Research Association, 1950.) 10s. [155

Papers of the Royal Commission on Population. Vol. 4: Reports of the Biological and Medical Committee. Pp. iv+52. (London: H.M. Stationery Office, 1950.) 1s. 6d. net. [165

Bulletin of the British Museum (Natural History). Mineralogy, Vol. 1, No. 1: Note on the Kapiti Phonolites and Kenytes of Kenya Colony, by W. Campbell Smith; Rocks collected by W. Thesiger in Oman, Arabia, in 1946–7, by P. M. Game. Pp. 24+3 plates. (London: British Museum (Natural History), 1950.) 5s. [165

Papers of the Royal Commission on Population. Vol. 5: Memoranda presented to the Royal Commission. Pp. iv+120. (London: H.M. Stationery Office, 1950.) 3s. net. [175

The Voters' Choice: a Special Report by Mass Observation. Pp. 14. (London: Mass Observation, Ltd., 1950.) 1s. [175

British Iron and Steel Research Association. Annual Report of Council, 1949. Pp. 107. (London: British Iron and Steel Research Association, 1950.) [175

Report of the Conference on Industry and the Universities, organized by the F.B.I. Education and Industrial Research Committees held at Ashorne Hill, Leamington Spa, 25 to 28 November 1949. Pp. 94. (London: Federation of British Industries, 1950.) 3s. [235

University of Leeds. Report to the Worshipful Company of Clothworkers of the City of London of the Advisory Committee on the Departments of Textile Industries and Colour Chemistry and Dyeing during the Session 1948–49. Pp. 32: Reports to the Worshipful Company of Clothworkers of the City of London by the Advisory Committee on the Departments of Textile Industries and Colour Chemistry and Dyeing on the Sessions 1938–39 to 1942–43. Pp. ii+117. (Leeds: The University, 1949.) [235

Wool Industries Research Association. Report of the Director of Research for 1949–50. (Publication No. 189.) Pp. 24. (Leeds: Wool Industries Research Association, 1950.) [235

Symposium on Stochastic Processes. (Reprinted from the *Journal of the Royal Statistical Society*, Series B, Methodological, Vol. 11, No. 2.) Pp. 150–282. (London: Royal Statistical Society, 1949.) 12s. 6d. [235

Abstracts on Agricultural and Horticultural Engineering. (Issued quarterly.) No. 1, Spring. Pp. ii+61. (Silsoe, Beds.: National Institute of Agricultural Engineering, 1950.) Annual subscription, 16s. [235

Other Countries

World Fisheries Abstracts. A bi-monthly Review of Technical Literature on Fisheries and related Industries. Vol. 1, No. 1, January–February. Pp. ii+46. 75 cents; annual subscription (including Handbook), 4 dollars. Handbook of World Fisheries Abstracts. Edited by Mogens Jul. Pp. iii+155. 75 cents. (Washington, D.C.: Food and Agricultural Organization of the United Nations; London: H.M. Stationery Office, 1950.) [95

United Nations Documents Index: United Nations and Specialized Agencies Documents and Publications. (Monthly.) Vol. 1, No. 1, January. Pp. iii+82. (Lake Success, N.Y.: United Nations; London: H.M. Stationery Office, 1950.) Annual subscription, 7.50 dollars; 50s. [95

Proceedings of the United States National Museum. Vol. 100, No. 3262: Mosquitoes of the Genus Tripteroides in the Solomon Islands. By John N. Belkin. Pp. 201–274. (Washington, D.C.: Government Printing Office, 1950.) [95

Proceedings of the American Philosophical Society. Vol. 94, No. 2: Intellectual Freedom and other Papers read at the Autumn General Meeting of the Society, November 4, 5, 1949. Pp. 89–184. (Philadelphia: American Philosophical Society, 1950.) 1 dollar. [95

Hyderabad Geological Series. Bulletin No. 6: A Popular Geology of Hyderabad. By Dr. A. M. Heron. Pp. vi+58. (Hyderabad: Government Press, 1948.) 1.4 rupees. [115

Journal, Hyderabad Geological Survey. Vol. 5, Part 2: Synopsis of the Purana Formations of Hyderabad. By Dr. A. M. Heron. Pp. 129. (Hyderabad: Government Press, 1949.) [115

Government of Hyderabad. Annual Administration Report of the Department of Mines and Geological Survey for the Years 1356 and 1357 Fasli (1946–47 and 1947–48). Pp. iv+66. (Hyderabad: Government Press, 1949.) 2.10 rupees. [115

American Philosophical Society. Year Book 1949, January 1, 1949–December 31, 1949. Pp. 467. (Philadelphia: American Philosophical Society, 1950.) [115

Indian Science News, 3: Synthetic Petrol. By Dr. S. L. Bhatia. Pp. xv+92. (Delhi: The Author, University of Delhi, 1950.) 2 rupees. [115

Transactions of the Bose Research Institute. Vol. 17: J. C. Bose's Plant Physiological Investigations in relation to Modern Biological Knowledge. By Dr. D. M. Bose. Pp. vii+80. (Calcutta: Bose Research Institute, 1949.) [115

The Rockefeller Foundation: a Review for 1949. By Chester I. Barnard. Pp. 85. (New York: Rockefeller Foundation, 1950.) [115

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 240: Studies on Dietary and other Factors affecting the Serum-Calcium Levels of Sheep, Parts 1–6. By Dr. M. C. Franklin, R. L. Reid and I. L. Johnstone. Pp. 77. (Melbourne: Government Printer, 1948.) [115

Publications de l'Institut National pour l'Étude agronomique du Congo Belge. Série scientifique No. 45: Étude botanique des Copaliers du Congo Belge. Par Dr. J. Léonard. Pp. 158. (Bruxelles: Institut National pour l'Étude agronomique du Congo Belge, 1950.) 130 francs. [115

Southern Rhodesia. Report of the Director, Geological Survey, for the Year 1949. Pp. 10. (Salisbury: Government Printing Office, 1950.) [155

Cahiers de l'Institut d'Études polonaises en Belgique. 6: i. On some Geographical Problems of the Palestine Rift Valley; ii. The Geographical Bibliography of Iraq, 1828–1944. By Stefan Legezynski. Pp. vii+36. (Bruxelles: Institut d'Études polonaises en Belgique, 1950.) [155

University of Texas. Publication No. 5007: Cytological Studies on Gall Midges (Cecidomyiidæ). By M. J. D. White. Pp. 80. (Austin: University of Texas, 1950.) 1 dollar. [155

Polska Akademia Umiejetności. Acta Monographica Musei Historiae Naturalis, 3: The Apterygotan Fauna of Poland in relation to the World-Fauna of this Group of Insects, Families Anuridae and Pseudachorutidae. By Jan Stach. Pp. 122+15 plates. (Kraków: Polska Akademia Umiejetności, 1949.) [155

Fondation Universitaire. Vingt-neuvième Rapport Annuel, 1948–1949. Pp. 124. (Bruxelles: Fondation Universitaire, 1950.) [155

Smithsonian Miscellaneous Collections. Vol. 111, No. 11: Larvæ of the Elaterid Beetles of the Tribe Lepturoidini (Coleoptera: Elateridæ). By Robert Glen. (Publication 3987.) Pp. v+246. (Washington, D.C.: Smithsonian Institution, 1950.) [155

Annals of the New York Academy of Sciences, Vol. 52, Art. 6: The Place of Statistical Methods in Biological and Chemical Experimentation. By Edwin J. de Beer, Lloyd C. Miller and 14 other Authors. Pp. 789–942. (New York: New York Academy of Sciences, 1950.) 2.25 dollars. [155

An Account of the Genus Dioscorea in the East. Part 2: The Species which Twine to the Right, with Addenda to Part 1, and a Summary. By D. Prain and I. H. Burkill. (Annals of the Royal Botanic Garden, Calcutta, Vol. 14, Part 2.) Pp. viii+211–528+xx+plates 86–150. (Alipore: Bengal Government Press, 1939.) 67 rupees; £5. [155

Royal Society of New Zealand. Report of the Sixth Science Congress, May 20–23, 1947. Edited and published under the authority of the Council as Transactions of the Royal Society of New Zealand, Vol. 77, Part 5. Pp. viii+412+16 plates. (Dunedin: Otago Daily Times and Witness Newspapers Co., Ltd.; London: High Commissioner for New Zealand, 1949.) [155

Fortschritte der Mineralogie. Herausgegeben von der Deutschen Mineralogischen Gesellschaft unter der Redaktion von Prof. Dr. Carl W. Correns. Band 26 (Jahrgang 1947). Pp. iv+166. (Stuttgart: E. Schweizerbart'sche Verlagsbuchhandlung (Erwin Nägele), 1950.) [175

State of California Department of Natural Resources: Division of Fish and Game, Bureau of Marine Fisheries. Fish Bulletin No. 75: California Sharks and Rays. By Phil M. Roedel and Wm. Ellis Ripley. Pp. 88. (Terminal Island, Calif.: California State Fisheries Laboratory, 1950.) [175

Proceedings of the California Academy of Sciences, Fourth Series. Vol. 26, No. 11: The Wasps of the Genus *Solierella* in California (Hymenoptera, Sphecidæ, Larrinæ). By Francis X. Williams. Pp. 355–417 (plates 11–21). Vol. 26, No. 12: Snakes of the Kiukiang-Lushan Area, Kiangsi, China. By T. Paul Maslin. Pp. 419–466. Vol. 26, No. 13: Notes on California Isopods of the Genus *Armadilloniscus*, with the Description of *Armadilloniscus coronacapitalis* n.sp. By Robert James Menzies. Pp. 467–481 (plates 22–26). (San Francisco: California Academy of Sciences, 1950.) [175

United Nations: Department of Social Affairs. Bulletin 3: Housing and Town and Country Planning. Pp. iii+118. (Lake Success, N.Y.: United Nations; London: H.M. Stationery Office, 1950.) 1 dollar; 7s. 6d. [175

Transactions of the National Institute of Sciences of India. Vol. 3, No. 4: A Contribution to the Morphology and Anatomy of the Cyclanthaceæ. By K. R. Surange. Pp. 159–209+6 plates. (Delhi: National Institute of Sciences of India, 1949.) 9 rupees. [235

University of Natal: Wattle Research Institute. Report for 1949. Pp. 43. (Pietermaritzburg: Wattle Research Institute, 1950.) [235

Abridged Scientific Publications from the Kodak Research Laboratories. Vol. 30, 1948. Pp. 462+xiii. (Rochester, N.Y.: Eastman Kodak Company, 1949.) [235